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ABSTRACT

The purpose of this paper is to examine the goals of the National Science Foundation teacher institute programs and the extent to which these goals have been achieved. Efforts or evaluation by various methods are reviewed, together with their results and the consequent modifications made in the programs. Some further evaluation studies which might be profitable are suggested. (Author)

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NSF TEACHER INSTITUTES:
GOALS AND EVALUATION OF ACHIEVEMENT

TES STAFF

MAY 1967

SE 023 794

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

May 1967

PPB -- SPECIAL STUDY -- 1967

Science Education -- Question 4

QUESTIONS: What have been the goals of the National Science Foundation's program of teacher institutes, and to what extent have they been achieved?

What has been done to evaluate the institutes and what has been learned?

What changes in kind and level have been made over the years as a result of the evaluations? And what other types of teacher training mechanisms have been or could be devised as a result of these evaluations and with what results?

What further practical steps should NSF take to evaluate its institutes?

May 1967

NSF TEACHER INSTITUTES: GOALS AND EVALUATION OF ACHIEVEMENT

The purpose of this paper is to examine the goals of the National Science Foundation teacher institutes programs and the extent to which these goals have been achieved. Efforts of evaluation by various methods are reviewed, together with their results and the consequent modifications made in the programs. Some further evaluation studies which might be profitable are suggested.

I. Introduction

The ultimate objectives of NSF activities in the improvement of science education are to ensure that a sufficient quantity of well-trained scientists and engineers are prepared for the Nation's needs, and to equip the remainder of the population to live in a scientific world by being properly conversant with science, its methods, objectives, its achievements. As one means contributing toward these objectives, institutes for teachers have the goal of improving the subject-matter competence of teachers at all academic levels--elementary, secondary, and collegiate.

The original goals of Teacher Institutes were to:

"1. Increase the effectiveness of teachers, by broadening and up-dating their scientific background.

2. Renew the interest in and attitude of teachers toward science and their task, as a factor in the motivation and encouragement of their students.

3. Improve communications, sympathy, and understanding between groups (researchers vs. teachers, for example)."*

* "Basic Features of Plan for College Teacher Institutes, Research Education Program," April 16, 1953.

As the Institutes have developed since 1953, the various institutes have sought these general goals by focusing on one or more of the following objectives:

a. Updating of subject-matter knowledge for those who were once adequately prepared;

b. Remedial training for teachers who were initially ill-prepared;

c. Specific background training to equip teachers to teach newer curricular materials;

d. Training in depth to enable teachers to meet new, higher standards (such as those represented by a master's degree); and

e. Advanced specialized training for teachers and supervisors preparing for positions of leadership in science education.

The earliest NSF institutes, patterned after models initiated by industry and some universities, were Summer Institutes of 6 to 8 weeks' duration with the first of the above objectives. From the experience gained in these early efforts, the objectives have been diversified as indicated above, while at the same time other formats for institutes were developed by the Foundation to help meet these varied objectives. Academic Year Institutes providing full-time study at a university were started in 1956-57; in 1957, the In-Service Institutes, offering part-time study in the evenings or on Saturdays, were initiated.

The original Summer Institutes, for college teachers, were followed in 1954 by Summer Institutes for secondary school teachers. The original Academic Year Institutes were enlarged in 1959 to include some college teachers, as were the In-Service Institutes in 1961. Both Summer Institutes and In-Service Institutes for Elementary School Personnel were begun in 1959. This capsule history only hints at the evolution of the various programs, which was based in large part on the continuing evaluations of each experimental phase; a fuller discussion of these programs is given in Appendix A.

II. Evaluation

A. Methods. Evaluation of teacher institutes has taken a number of forms:

(1) Analytical studies by staff members, based on reports of directors and other collected information. (See Appendix B)

(2) Statistical analyses of data accumulated from participant application records.

(3) Reports of visits by staff and consultants to institutes in progress.

(4) Group discussions at annual conferences of institute directors.

(5) Studies of effectiveness of particular institutes by their staff or in graduate student theses. (See Appendix D)

(6) Contract studies by independent research firms. (See Appendix C for abstracts of these studies)

The most complete summarization yet made of the institute activities of the Foundation is a history and evaluation of the programs for the period 1953-65, entitled "An Investment in Knowledge - A Study of the National Science Foundation's Summer Institutes Programs," by Hillier Krieghbaum and Hugh Rawson, written under a contract with New York University. The final chapter, "Measures of Impact," describes the impact of the institutes on science education, as shown from various evaluation studies, from collected opinions of experts in teacher training and science, and from the authors' extensive visits to institutes and complete access to NSF files. This chapter is reprinted as Appendix F.

B. Areas of investigation. The following general questions have given rise to investigations:

(1) Are individual institutes accomplishing their specific objectives?

(2) What are the characteristics of the teacher populations of the country--both the participants and the non-participants?

(3) What are the effects upon the participating teachers?

(4) What are the effects upon the schools and the students therein?

(5) What are the effects upon the institutions conducting the institutes which may influence their programs of pre-service training of teachers?

Each of these questions has had continuing attention by one or more of the methods cited.

C. Findings. Significant conclusions resulting from study of each of the areas of investigation cited above can be summarized as follows:

(1) Individual institutes have, by and large, attained their specific objectives. Staff visits by Northrop to the 1954 Summer Institutes indicated that they were successful in improving the participants' knowledge of subject matter, and that there was a need for more institutes. The 1955 Summer Institute participants were questioned by the Bureau of Social Science Research (Appendix C, Contract C-39) both before and after the institutes; it was found that immediate benefits were received by the participants, both in subject-matter content and through contacts with other teachers. Most participants thought they would utilize their experiences in their teaching. BSSR also studied the 1956 participants (Contract C-44) with respect to the pre-institute information and motivation to attend, finding that both stipends and academic credits are influential in attracting applications, and that participants were highly satisfied with the subject matter learned. Science Research Associates (Contract C-55) interviewed a sample of the teachers in the 1956 summer institutes and found the institutes still effective in updating the teachers' knowledge, in renewing their enthusiasm for their subjects, and in providing new ideas for presentation of subject matter. Since 1956 the surveillance of individual institutes and the participants therein has been conducted primarily through visits by staff members or consulting scientists (mostly former staff members) to the institutes while in operation. Such visitors have observed the quality of the operation, have collaborated with the directors in suggesting improvements, and have provided valuable liaison between the sponsoring institutions and the Foundation. Hausman (1957) and Young (1959-61) have prepared comprehensive summaries of these visits to Summer Institutes.

In a major paper in 1960, Pino and Phelps summarized the findings of 10 NSF staff members and 10 consultant scientists and mathematicians who constituted teams which visited the 32 Academic Year Institutes which were in operation during the academic year 1959-60. The following topics make up the major portion of the evaluation: (1) the accomplishments of the Academic Year Institutes in improving the competence of science and mathematics teachers were meeting the expectations of both participants and staff; (2) the continued need for such teachers to pursue advanced subject-matter studies in year-long programs was apparent; (3) improvement of some Academic Year Institutes was needed, especially by having each institute concentrate on one or more disciplines in which the staff and institution are particularly interested, rather than in a multiple-field effort in which some departments were not interested; (4) impracticality of transforming the AYI program into a national fellowship program was evident everywhere; (5) experience gained in the program could possibly be applied to the improvement of the undergraduate preparation of potential teachers but little evidence of action was apparent; and (6) institutes were apparently successful in providing additional training to poorly-trained college teachers who are themselves trainers of teachers.

Regular use is made of reports of directors and of reports of visits by staff members and consultants in considering renewal grants. These visits are made cyclicly--about one third of the institutes per year--and it is estimated that a recent site visit report is available for about 80% of renewal proposals; a central file on all visits, filed by institution, is maintained for fuller information and program coordination.

(2) The science and mathematics teacher population as the potential clientele of the institutes has been studied. OEIR (Appendix C, Contract C-62) studied all the applicants to the 1957 Summer Institutes and the 1957-58 Academic Year Institutes, comparing the professional qualifications and job responsibilities of both acceptees and rejectees. For full-time teachers of science and mathematics the differences between the two groups were small. Most applicants were teaching both mathematics and science, and many of these early applicants had master's degrees. This study was duplicated and extended in 1960 by Science Research Associates (Contract C-159) and in 1964 by Psychometrics Consultants (C-349).

While it was evident in 1960 that the applicant population--both acceptees and rejectees--did not have as strong an academic background as in 1957, and therefore was more representative of the total population, the continuing insignificant differences between the acceptees and rejectees indicated that many of the 60,000 non-participating applicants could have profited from additional institutes in the same way that the 30,000 participants did, and that the need for such institutes will continue for some time. While among the applicants the acceptees and rejectees tended to look much alike, a study by the American Institute for Research (Contract C-222) in 1962 of teachers who had never applied indicated much greater apathy in this group with respect both to science and to their teaching assignments. Their subject-matter backgrounds were weaker, and their interests more diffuse.

Beginning in 1960, Blanche Associates prepared for four consecutive years comprehensive summaries of the data furnished by each applicant--address, teaching assignment, previous institute attendance--and collated over 200,000 individual card entries annually so as to measure the multiple applications; it was found that the average applicant applied to about three institutes (with little annual variation) in Summer Institutes or Academic Year Institutes; for the (local) In-Service Institutes usually only one application was filed. This series of applicant data has been continued since 1964 as a function of the NSF Data Processing Center.

(3) The effects on participating teachers have consistently been found by institute visitors and contract evaluators to be strongly positive. While some teachers came to the institutes seeking new methods for teaching science, the institute emphasis on the subject matter itself made an ultimate impression, and they have returned to their duties with renewed confidence in their own qualifications. (For early studies see

Appendix C, contracts C-39, C-44, and C-55). In 1960, BSSR (Contract C-124) made a study of the long-range effects on a group of 1957 participants, as compared with a control group of non-participants. This showed clearly that these teachers were more effective in numerous ways and that this was attributed by their colleagues to their institute participation. Unexpectedly, this survey also showed that a number of teachers had participated for more than one summer, and that the effect was proportionally greater than for the same number of single participations.

In addition to continuing reports of visitors to institutes that the participants feel that the programs are effective in improving their subject-matter understanding, it is noteworthy that a large number of letters received by the Foundation recently from teachers, supervisors, educational officials, and professional societies have universally commended the positive effects of the institutes on the participants (as well as upon the science education programs of their schools).

In a staff study of reports from directors of previous Academic Year Institutes in 1964 (reprinted in Appendix E), Carnell concludes that the former participants in these institutes had increased their stature as local leaders in science education, and were much in demand as consultants for curriculum planning and in-service training; in general their responsibilities had increased in importance. Also, some of the participants had reported substantial increases in the enrollments in science and mathematics in their schools--as much as 100% increase in the 9th and 10th grades. A not insignificant effect of Academic Year Institutes upon their participants was in the salary increases they received after attendance, averaging $800 to $1,000; about two-thirds of these participants received master's degrees which affected not only their salaries but also their eventual salary ceilings.

(4) The effects upon schools and their students was shown in the BSSR participant follow-up study in 1956 (C-39). Courses and teaching were modified; laboratory was improved. These same effects were observed in the 1957 follow-up by SRA (C-55) and in the 1960 BSSR report (C-124). The students of former participants performed more effectively; the better students sought out their classes; grades improved. The schools (secondary) showed such effects as more advanced sections, changed course content, and more laboratory work.

Carnell's study of Academic Year Institutes noted that in some cases as much as 50% of the school's courses in science and mathematics had been upgraded after the participant's return from an AYI, and that in other cases the science program of the entire school system had been advanced through in-service training programs conducted by these returnees.

(5) The effects upon the institutions conducting the institutes include a much more widespread (though not universal) interest by college faculty in the problems of the schools and their teachers. This has led to better communication on campus between education faculties and science faculties, and has led to an active interest in some professional societies (MAA and AAAS, for example) in clearly defining the needs of teachers. (Cf. Krieghbaum-Rawson, Appendix F.)

The 1964 Carnell study of Academic Year Institutes (Appendix E) attempted to evaluate the permanent effect on the institutions of the new graduate offerings for teachers; most institutions seemed to feel that these new courses were good but would have to be dropped for lack of enrollment if the NSF ceased to provide support for teachers. Some institutions felt the courses could be transferred to the summer sessions.

The pre-service training of future teachers has been influenced by the participation of college faculty in Summer Institutes and Conferences and in Academic Year Institutes. In the latter, close association with high school teacher participants has helped the teacher-training faculty participants to understand high school needs. But, in general, it does not appear from any reports that a great revolution in the undergraduate training of teachers has been effected yet.

Reports of directors and visitors also point out that the operation of institutes, particularly at smaller institutions, permits a more efficient utilization of facilities during normally slack periods (summer, evenings, weekends).

III. Major Changes in Institutes Programs Resulting from Evaluation Studies.

1. The earliest evaluations (1954 to 1957) indicated strong enthusiasm for the summer institute mechanism; consequently the program was enlarged substantially from year to year. As a result of these surveys, the Foundation developed a series of annual meetings of directors of institutes to discuss their various accomplishments and the evaluation reports, to assist these directors in mounting continually improved programs.

2. An analysis by Young early in 1960 of reports from all Summer Institute directors indicated that 110 directors out of 245 responding thought that their institutes were designed so that some of the participants could attend more than one summer, that typically three summers would constitute a good program, and that 83 of these series of summers would be applicable to a graduate degree. The 1960 BSSR study (C-124) indicated that those teachers who had attended summer institutes for several years (unplanned by the Foundation, and not necessarily at the same institution every year) had strongly increased their effectiveness as teachers.

A general plan for sequential summer institutes was laid out in a paper by Bennington (Appendix B) in 1960, and a complementary plan for multiple-year funding of either sequential or unitary summer institutes, also by Bennington, accompanied it. One feature of both plans permitted combinations of Summer Institutes and In-Service Institutes as a unified sequential program with multiple-year funding, designed for local participants who could thus progress toward a master's degree more rapidly. This introduction of officially recognized sequential institutes--in operation in the summer of 1962 for the first time--was probably the single greatest change in the Institutes program which resulted from evaluation of the earliest programs.

3. The comprehensive Pino-Phelps staff-consultant study of Academic Year Institutes in 1960 covered all the institutes in the first year of operation at the planned program size (to serve 1% of the Nation's teachers). The high quality of the programs led to a decision to continue the program indefinitely as a regular part of the Institutes program. Comparisons of different kinds of institutes led to greater emphasis on specialized institutes in a single field (notably, in mathematics), and many of the earlier multiple-field institutes were modified to emphasize those fields which the institution was best equipped to handle.

The Carnell study in 1964 (Appendix E) reinforced the conclusions that the kind of advanced training for leadership in science teaching which is supported by this program could not continue effectively unless the institute program is continued at at least the same level.

4. The experimental inclusion in three Academic Year Institutes of "teachers of teachers" from teacher-training institutions proved so effective in the 1960 evaluation that this effort to influence the pre-service training of teachers was expanded gradually so that by 1964 fifteen institutes included such participants.

5. The 1960 and 1964 studies of the attributes of the Summer Institute applicant populations (C-159 and C-349) indicated--especially in 1964--that the characteristics of accepted and rejected teacher populations were essentially the same in various types of institutes. Thus the large backlog of non-acceptees (annually about twice the size of the acceptee group), indicates continued need for a number of years of a broad program of institutes of all types. The comprehensive historical study in 1965 of the Summer Institutes program by Krieghbaum and Rawson came to the same conclusions (Appendix F).

6. The BSSR follow-up study of 1956 participants in Summer Institutes for Secondary School Teachers (C-44) noted especially their comments on the need for institutes for elementary school personnel. Other institute observers noted this, too, and the programs of Summer Institutes and In-Service Institutes for Elementary School Personnel were started in 1959 as a result.

7. It s[illegible] there are numerous changes in the programs from year to year w[illegible] individually small but cumulatively keep the programs in line with continuing staff estimates and studies. These staff actions have resulted from the extensive program of on-site visits to institutes by staff and consultants, thorough discussions of the programs at meetings of directors, and annual comprehensive statistical surveys of applicant data and participant data, together with the findings of the various contract studies.

8. It must be remembered that the elementary and secondary school teachers are more or less free agents with respect to how they teach. Usually they are not free agents with respect to what they teach. Typically the curriculum and general course content are specified in an approved syllabus which the teacher is expected to follow. The syllabus in turn is approved by higher administrative authority. Thus, the classroom teacher seldom has much direct control over the course she teaches. In principle, one cannot expect to obtain a material change in the curriculum or courses of a school by virtue of one or even more teachers in that school having attended an institute purely as an individual.

One of the results of the evaluation of teacher institutes is the not-unexpected disclosure that they were not an efficient way to effect reforms of the instructional programs of schools. The institute, as a mechanism, cannot be wholly faulted for this failing because that objective cannot rationally be assigned to institutes. Nonetheless, if educational reform is to be real and lasting it must reach the curriculum and course content themselves.

Accordingly, and although reasonably satisfied as to the effectiveness with which institutes as such achieve results consonant with their nature, the Foundation has chosen to emphasize other kinds of programs better suited to effecting the instructional programs within schools. Since the increasing emphasis on the latter type of program (the Cooperative College-School Science Program being the prototype and primary example) must take place within a limited over-all budget, this has resulted in a decrease in NSF support of institutes as such. Institutes are concerned virtually entirely with the further training of a teacher as an individual. In contra-distinction, the CCSS Program provides support for projects in which school (elementary and secondary) authorities collaborate closely with academic scientists and mathematicians mainly in improving some segment of the school systems' instructional program according to those systems' educational objectives. This type of project melds curriculum and course development (or adaptation) with the further education of a specific school system's teacher in ways directly relevant to that system's needs and aspiration. That type of program was not possible until relatively recently because of the lack of interest previously on the part of school authorities.

IV. Further Evaluation Proposed

It is expected that the surveillance of institutes and CCSS projects in operation through visits by staff and consultants and through study of institute reports will continue; this is necessary to keep the program operation abreast of the needs. Similarly, the collection and analysis of data on the participant and applicant populations will be continued. In addition, areas which appear to need special studies in the near future are:

1. What has been the impact of individual teachers trained at institutes on their school systems. Of those trained in CCSS projects?

What have been the effects of the teacher attending a unitary institute versus the one attending sequential institutes versus the one attending an academic year institute?

What has been the effect of the returning classroom teacher as compared with the returning subject-matter supervisor or consultant?

Does a group of teachers trained through a NSF Cooperative College-School Science project for teacher training have more, the same, or less of an impact on the school systems than several individual teachers trained at random institutes?

Is the effectiveness of a concentrated teacher training project such as CCSS enhanced by having a core of teachers trained in institutes?

How does the impact of each type depend upon the size of the school system?

What impact upon a school or school system is made when a substantial number of its teachers attend an In-Service Institute in the neighborhood?

2. What are the characteristics of the teacher population that attends, or applies for, In-Service Institutes?

A study comparable to the Psychometrics Consultants' 1964 study of Summer Institute acceptees and rejectees (C-349) is suggested, to study those variables which seem most relevant in determining the shape of future institute programs.

3. What has been the total effect of 12 years of Academic Year Institutes on the participants?

A complete survey of all the 15,000 Academic Year Institutes participants should be made. (An earlier incomplete survey by Carnell is reported in Appendix E.) The Foundation needs to know whether a real cadre of leadership has been created:

Are former participants teaching, or have they gone on into supervisory or administrative positions?

Are they employed in high schools, junior colleges, or elsewhere?

How many have obtained a doctorate?

How many are conducting institutes or other in-service training projects?

4. To what extent are institutes needed in the next several years?

No recent information is available as to the real training needs of in-service teachers. It is suggested that a survey of a large, stratified sample of schools be made, covering all teachers in those schools, seeking information on:

How much undergraduate and graduate training in subject matter have the teachers had? How much additional training is needed?

To what extent are teachers assigned to teach subjects outside their areas of competence?

What types of teacher training programs would be most useful?

What is the relationship of training needs to course content revisions in the school curriculum? (A by-product would be a good picture of the current status of implementation of curricular reform through use of NSF or other new curricular materials.)

5. What is the ultimate effect of teacher institutes upon the students of these teachers?

This can perhaps be studied through analyses of the National Merit Scholarship applications; the quality and quantity of college freshmen taking science and mathematics; and, for college teacher institutes, the quality and quantity of college graduates in science, science teaching, and engineering.

6. What implications can be derived from the "International Study of Achievement in Mathematics" (Wiley, 1967), a study of 8th garde and 12th grade achievement levels in 12 countries? The mediocre showing of the United States in this comparison is based upon voluminous test and interview data. It is likely that further analysis of this raw data may give insights into better methods of teacher training, needs for new course offerings and approaches in institutes, etc.

7. What impact are funds from the Elementary and Secondary Education Act of 1965, and other federal-state-local programs, having upon improving teacher education in science and mathematics?

Current decisions as to levels of funding for NSF teacher education programs must take into account this impact (which might be determined during the in-depth school system study projected in item 4). An important result of such a study could be information as to kinds of projects which NSF should develop so as to provide the schools and school systems with adequate resource personnel to make optimal use of the vastly-increased Federal support in local-action projects.

V. Evaluation Needs for College Teacher Institutes

Although current sources of information about the effectiveness of Summer Institutes for college teachers furnish a considerable amount of knowledge, it is not enough of the type required for decision-making at the BOB level. As a matter of course we get a considerable amount of imput from participants, from project directors, from staff members and consultants whom we involve in the visiting program.

In the case of Project Directors, direct contact at Directors' Meetings brings the Foundation knowledge in a variety of forms ranging from formal reports presented by chosen individuals to bits of information peculiar to the individual project. Obviously, correspondence between directors and the program staff augments the comparatively unstructured accumulations of facts. The Foundation has a program of visiting the educational projects being supported, and the ordinary type of report sent in after a visit has been made also adds to this accumulation.

To obtain useful information about participants, the staff of College Teacher Programs has begun to ask for visitors' reports that include individual interviewing of participants. Mainly, however, information about participants has up to now come from three sources:

(i) Applicant Record Cards. These each director sends to the Foundation in two lots, one representing participants and the other representing non-participants.

(ii) Status Report Forms. This is basically a roster of participants with information about them.

(iii) Final Reports. These are mainly in narrative form, and do not as a rule present statistical material except to correct information previously turned in through the Status Report Forms.

On the whole, enough information about participants is received to make it possible to profile the participant groups in certain important respects: average age, years in service as teachers, average number of children, etc. What should be done, and what has not been done, is to get information about participants one or three or five years after the time of participation, and the program staff is devising plans for doing so. Until we implement these plans we shall obviously lack the information enabling us to judge the effectiveness of institutes.

What is also needed, and what has not in the past been easy to come by, is information on applicants who fail to be placed, although the new Applicant Record Form should help to correct this. Special questionnaires project directors ask participants to fill out yield a considerable amount of information. Such procedures have led the professional societies to become very interested in institutes as a vehicle for spreading knowledge of new course content material: observe for example the strongly-worded resolution asking for greater support of Summer Institutes for college teachers of mathematics recently sent by the Board of Governors of the American Mathematical Association to the Congress of the United States and to the officers of the National Science Foundation. These societies have shown a capability for making their own studies of the effectiveness of the Foundation's programs.

The Foundation must start making greater use of its data processing equipment to pursue special studies of College Teacher Programs. In the past project directors have often collected useful information by having the participants, at the end of their attendance, fill out questionnaires of the sort that NSF could give over to machine processing. The Foundation should now consider asking each participant to fill out a form at the end of his participation, a form devised for machine processing. The filling of similar forms can also be requested from participants a given number of years after they participated, to determine what changes, if any, these programs are bringing about.

We should go beyond this, however, and provide support for studies to be made by organizations such as the American Council on Education, acting independently of NSF. These studies can be set up to furnish information on a variety of questions such as those in the attached list. An important class of questions are those directed at comparing the effectiveness of the Foundation's current programs in meeting stated objectives as compared with alternatives not yet tried, or inadequately tried. Another class would be directed at the correctness of the Foundation's decisions with respect to levels of support. It may be assumed for example that a given program will not have a significantly-lasting impact if supported so as to meet the need to which it responds at a level below a certain percentage of need saturation. This percentage may be low or high in a given case, but failure to locate it means that money is largely wasted when support is below the "critical" level that corresponds to it.

An example of a comparison needing to be made between on-going programs and suggested alternative programs would compare two types of institutes. One is the type of the Summer Institutes now largely supported in College Teacher Programs, and the other is a type under discussion by the program staff. The first is directed at teachers applying to participate on their own individual initiative. The other type would be exemplified by a project conducted at a university as a result of a group of colleges acting together to propose an institute in a given subject-matter area, with each college sending its quota of participants. Such an institute could entail a loose post-institute federation of participants that would increase enormously the chances that participation would lead to definite improvements in the curricula of the participating colleges.

Questions to be answered in evaluating College Teacher Programs:

1. What influence has participation in College Teacher Program projects had on the participant?

   a. What gain in information or outlook resulted from participation?
   b. What change in the content of an offered course resulted from participation?
   c. Did participation result in the encouragement and development of personal research or that of other members of the department?
   d. Did participation result in advancement at the home institution?
   e. Did participation result in the stimulation of further professional efforts such as studying for a doctorate, seeking a Science Faculty Fellowship, etc.?
   f. Has participation had any influence on long-term career plans?
   g. Have any publications resulted that are an outgrowth of participation?
   h. Has participation stimulated the placement of additional efforts to place more time in research or related professional work relative to time spent in teaching in the classroom?
   i. What summer activities, if any, have been stimulated by participation?

2. What influence has participation in College Teacher Program projects had on the home institution of the participant?

   a. What changes, if any did participation have on courses already offered?
   b. Did participation result in any new courses being offered?
   c. Did participation result in any curriculum modification?
   d. Did participation result in increased undergraduate research or research participation?
   e. Has there been any increased awareness of other Foundation activities that has resulted from participation?
   f. Has participation encouraged cooperation with other institutions that are similar to yours?
   g. Has participation encouraged any cooperation with major institutions?
   h. What has been the reaction of the department chairman to participation?
   i. What has been the reaction of the administrative officers to participation?

3. What influence have the College Teacher Programs had in meeting wider needs?

   a. How effective have the College Teacher Programs been in disseminating information on new areas, and how effective have they been in stimulating activity in them?
   b. How effective have the College Teacher Programs been in meeting the needs of special groups, such as junior college teachers?
   c. What role should the professional societies play in stimulating special projects within the College Teacher Programs?
   d. Is there a "type" of institution which makes maximum use of College Teacher Programs?

e. What kinds of individuals are being turned down as participants? What kinds are being accepted? Are there any significant differences between individuals in these two groups?

f. What is the reaction of the host institution to sponsoring College Teacher Programs?

g. What groups of college teachers are being ignored that should be served by College Teacher Programs?

h. What additional needs of college teachers should be served by new College Teacher Programs?

Appendices

A. "Orientation, Purpose, and Scope of NSF Teacher Training Programs," by C. Russell Phelps, July 25, 1963.

B. Staff Papers Related to Evaluation of Institutes.

C. Reports prepared under Contract.

D. Independent Studies Related to Evaluation of Institutes.

E. "Evaluation of the Countrywide Academic Year Institutes Program" by Paul Carnell, November 1964.

F. "Measures of Impact," final chapter of "An Investment in Knowledge - A Study of the National Science Foundation's Summer Institute Programs" by Hillier Krieghbaum and Hugh Rawson, 1965.

NATIONAL SCIENCE FOUNDATION
Washington 25, D. C.

July 25, 1963

MEMORANDUM TO MEMBERS OF THE DIVISIONAL COMMITTEE FOR SCIENTIFIC PERSONNEL AND EDUCATION

Subject: Orientation, Purpose, and Scope of NSF Teacher Training Programs.

The discussions in this paper are divided into five sections, as in the following outline, with the sections further subdivided according to the organizational level at which teachers are employed--college, secondary school, or elementary:

I. Orientation and Purpose of Institutes: Historical

II. Scope of Current Teacher Training Programs: Comparison with estimated needs

III. Fulfilling the Purpose: Effects of Institute Programs

IV. Relationship between Pre-Service Training and In-Service Training Programs

V. Projected Scope and Orientation of Institutes

I. Orientation and Purpose of Institutes: Historical

In recognition of the importance of science education the Congress through the National Science Foundation Act authorized and directed the Foundation

> to develop and encourage the pursuit of a national policy for the promotion of . . . education in the sciences; . . . (4) to award . . . scholarships and graduate fellowships in the . . . sciences. /Sec. 3(a)(1)/

The Act further stated that:

> In exercising the authority and discharging the functions referred to in subsection (a) of this section, it shall be one of the objectives of the Foundation to strengthen . . . education in the sciences . . . throughout the United States, including its territories and possessions, and to avoid undue concentration of such . . . education. /Sec. 3(b)/

In preliminary consideration of the Foundation's program, the Director and staff recognized that, although the fellowship program was specifically named in the Act and was the largest financial outlay in the Division of Scientific Personnel and Education, it was not necessarily the only and most effective method available to the Foundation for increasing the research potential of the nation; and that there were other means of promoting and strengthening education in the sciences than awarding fellowships to promising young men and women. They recognized that there would be no fellowships or grants to award nor a Register to maintain unless there was a continuous flow of young men and women into the sciences. And the people who had the greatest influence upon this flow were the teachers of science. It was further recognized that a need existed for financial support which would permit these teachers to increase their usefulness as developers of new scientific talent. At the meeting of the National Science Board on July 21, 1951, a program intended to give recognition and assistance to able science teachers was proposed:

> The program contemplated would be clearly experimental in nature, since this problem would require study. The Board felt that this program was important, and individual members of the Board mentioned a number of examples indicating the catalytic effect such a program would have. 1/

At a meeting in April 1953 of the Divisional Committee for Scientific Personnel and Education, the staff for Education in the Sciences presented the initial plan and reasoning for an "institutes program." After considerable discussion of the subject the Committee approved the initial plan, and following the meeting the plan was revised and put into action immediately.

1/ Minutes of the Seventh Meeting of the National Science Board.

The first type of training program supported by the Foundation was the "summer institutes." In the summer of 1953 two for college teachers were supported: one for mathematics teachers at the University of Colorado and one for physics teachers at the University of Minnesota. During the summer of 1954, three Summer Institutes for college teachers and one for high school teachers were supported. In 1955 support was given for five Summer Institutes for college teachers, two for high school teachers, and two institutes for college and high school teachers combined.

In January 1954, Dr. E. P. Northrop of the Department of Mathematics, University of Chicago, was appointed consultant for SPE. It was through his recommendations and efforts that many of the procedures and practices that are still used in the Institutes Program today were established: uniform stipends and allowances, conferences for the institutes directors, and ad hoc advisory panels. Out of the conferences of institutes directors grew the procedures for nationwide publicity, uniform application forms, selecting host institutions, etc.

During the summer of 1955 a major development took place in the Education in the Sciences Program. A staff paper dated August 10, 1955, proposed that the Foundation establish and support a High School Science Teachers Supplementary Training Program, to provide science subject matter training for teachers over a full academic year. The first two such programs ("Academic Year Institutes") were held at the University of Wisconsin and Oklahoma A&M during 1956-57.

On January 30, 1956, during the House of Representatives hearings on the 1957 budget of the Foundation, Congressman Evins asked: "Could you use $10 million instead of the three million dollars (the amount requested) for the high school teacher-training program at this time?" 2/

Although Dr. Waterman was constrained to indicate that he supported the budget as requested by the administration, Congress earmarked $9,500,000 for institutes with the following language:

> Potentially one of the most valuable programs the Foundation has is the one for the supplementary education of high school mathematics and science teachers, where a grant is awarded to the teacher to enable him to obtain further education in the field of science in which he is interested. It is planned that the teachers will attend certain universities to be selected and take refresher courses for approximately one academic year. The Foundation also has a very successful program for training in summer institutes. The committee considers these programs so important that it has earmarked $9,500,000 in the bill for grants under these two programs. This is an increase of $5,650,000 above the budget estimate for this activity. 3/

2/ Hearings before the Subcommittee of the Committee on Appropriations, House of Representatives, Eighty-fourth Congress, Second Session.

3/ Excerpt from Report No. 1847, which accompanies H.R. 9739, Independent Offices Appropriation Bill, 1957. This is the origin of the so-called "limitation" clause which has appeared in all NSF appropriations since.

During the spring semester of 1957 the Foundation moved toward rounding out the institutes program by supporting two in-service institutes for secondary school teachers on an experimental basis. These institutes were designed to provide evening, late afternoon, or Saturday courses in science or mathematics for the secondary school teachers in a given locality. They proved so successful the Foundation supported 21 such institutes in 1957-58 from the new appropriations and In-Service Institutes became the third major type of supplementary teacher training program.

The summer and fall of 1959 saw the Foundation supporting teacher training programs for elementary teachers and supervisors for the first time -- twelve summer institutes and eleven in-service institutes. Twenty "summer conferences" for college teachers were also held for the first time that summer.

For fiscal years 1960 and 1961 the appropriations for all of SPE were held at virtually the same level as for FY 1959 (see Table I). However, for FY 1962, the House committee again raised the minimum limitation of $37.6 million for supplementary training for secondary school teachers, requiring the Foundation to use for this purpose $5.4 million more than the amount proposed in the President's budget.

For 1963 the Institutes appropriations remained at the same level as 1962. These appropriations were used to support a total of 523 summer institutes, 35 college conferences, 316 in-service institutes, and 58 academic year institutes (see Table II).

The orientation and purpose of the various institute programs have all been directed toward the improvement of the teaching of science through improving the subject matter backgrounds of teachers. But since the problems and solutions have been necessarily somewhat different for the several teaching levels, the programs for these levels will be analyzed separately.

A. The Training of College Teachers

1. The original training of scientists for college and university teaching positions is a primary function of graduate schools, and the NSF Act made statutory provision for the establishment of fellowship programs so as to provide support and encouragement for this function (among others). The Graduate Fellowships, the Cooperative Graduate Fellowships, the Post-doctoral Fellowships, and the Graduate Teaching Assistant Fellowships have all been established to increase and improve the graduate training of scientists for positions of research and/or training.

The Foundation recognized, however, in the establishment of the Institutes programs in 1953 that the existing members of college faculties needed assistance in keeping up with the rapid advances in scientific knowledge. The first Summer Institutes were designed in collaboration with leading scientists, to provide an opportunity for college teachers to become familiar with the latest developments in their fields. This "refresher" type of Summer Institute for College teachers was an immediate

TABLE I

Historical Fiscal Summary of Institutes Section

Fiscal Year	Proposals Received	Grants Made	Institutes Supported	Applications Received	Individual Applicants	Participants Supported	Amount Requested	Total Amount Granted
1953	4	2	2	500	320	42	$ 99,320	$ 22,250
1954	6	4	4	750	240	97	80,060	50,500
1955	21	11	11	950	416	299	323,612	147,350
1956	49	26	29	4,050	1,734	1,390	1,714,178	1,123,450
1957	269	139	133	27,000	9,232	6,517	14,902,767	9,641,460
1958	423	231	230	36,000	13,522	10,432	23,603,872	12,361,350
1959	852	615	618	112,533	42,750	30,568	45,779,590	33,593,725
1960	1,157	658	661	183,507	62,761	31,212	67,171,214	35,028,760
1961	1,303	749	774	224,782	81,149	34,093	63,828,814	35,591,775
1962	1,472	876	912	245,290	92,516	40,695	68,390,559	42,961,635
1963	1,402	907	929	254,395	97,000	41,843	66,313,585	43,795,390
Totals	6,958	4,218	4,303	1,089,757	401,640	197,188	$352,207,571	$214,317,645

TABLE II - Types and Numbers of Institutes by Level of Education Supported in Summer 1963 and AY 1963-64

College Teachers:	*No. of Institutes	*No. of Stipends	*Total Amount Granted
Summer Institutes	75	2,058	$ 2,540,850
Academic Year Institutes	16	110	567,500
Conferences	35	985	578,300
In-Service	4	73	23,700
Sub-total, College Teachers	130	3,226	3,710,350
Secondary School Teachers:			
Summer Institutes	423	20,750	24,139,200
Academic Year Institutes	56	1,755	10,982,000
In-Service Institutes	267	13,423	3,512,780
Sub-total, Secondary School Teachers	746	35,928	38,633,980
Elementary School Personnel:			
Summer Institutes	33	1,036	1,062,300
In-Service Institutes	46	1,403	302,760
Sub-total, Elementary School Pers.	79	2,439	1,365,060
TOTALS	929	41,593	$43,709,390

*Includes appropriate portions of combined institutes, except that combined institutes are counted singly in the grand total number of institutes.

success, and the program has been gradually expanded in the past ten years so that currently there are 75 such institutes covering all fields of science. This summer over 2,000 college teachers are participating in these institutes. Data from FY 1962 experience indicates that about 1,200 institutions of higher education had faculty members participating in these programs especially designed to present current approaches to the fundamental knowledge in the several disciplines. Typically these institutes last six to eight weeks. Beginning in 1959, the Summer Institutes for College teachers have been supplemented by a program of Summer Conferences, similar to Institutes, but of shorter duration and usually devoted to a more advanced, intensive study of a specialized topic in science. These Conferences have been especially successful in reaching more college faculty members whose summer duties prevent them from attending the longer Institutes. Similarly, for the relative few who are able to take a year away from their duties, the Fellowships Section has established the Science Faculty Fellowships which provide for full time residence in a graduate school setting, where they may pursue courses, seminars, and other studies of their own choice. It should be noted, however, that the Fellowships and Institutes represent quite different approaches to the same problem of the need for refresher training: fellowships make use, on an individual basis, of existing offerings of university graduate schools, normally during the academic year, whereas Institutes and Conferences are specially created for groups of participants, and offer special courses and lectures which are not normally available anywhere during the summer months. In addition to these special offerings, institutes offer an unparalleled opportunity for the exchange of scientific information, teaching techniques, and curricular ideas among a homogeneous group of college teachers with similar problems in their teaching situations.

2. The extensive changes in the secondary school curriculum which have resulted from the new Course Content Improvement projects -- PSSC, SMSG, BSCS, etc. -- coupled with the widespread movement to transform teachers' colleges into general liberal arts colleges have created great difficulties for many of the science faculty members of these institutions. Many of these had their training partly in science and partly in professional education. But even those with strong science backgrounds have not been able to keep up with the rapid developments and philosophical reorientation necessary for training prospective teachers of the sciences. Consequently, beginning in 1959-60 a small number of these "teachers of teachers" have been selected as participants in the Academic Year Institutes for Secondary School Teachers, where they are enabled to study graduate level science and at the same time learn from their secondary school teacher colleagues in the institutes about the real problems of teaching science in the secondary schools. More recently, a few of the Summer Institutes and Conferences for College Teachers have been also oriented toward the particular problems facing these teacher-training professors.

3. In the last several years the rapid increase in college populations and the rapid emergence of new institutions of higher education -- especially junior colleges -- have created new problems

through a critical shortage of qualified scientists to fill teaching positions. This has led to the appointment of significant numbers of partially-trained individuals to full-time teaching positions. Recent studies of the NEA[4] have shown that about 13% of newly-appointed full-time college teachers of mathematics, and 11% of those in science, begin teaching without having achieved even the master's degree level in their fields. Significantly larger numbers have master's degrees, but little further training. Quite evidently these individuals are poorly prepared even for teaching freshman subjects, and yet their employment is necessary to fill existing vacancies. At the same time, their upgrading through summer studies is essential, but few universities offer appropriate graduate programs during the summer. Thus a need for special institutes to provide groups of them with additional subject matter background is imperative, and recent orientation of some of the Summer Institutes for College Teachers has been in the direction of sequential offerings in successive summers to fill this important gap.

4. In the specialized field of the training of technicians in post-secondary technical institutes, analysis revealed that the technical faculty of these institutions were frequently strong in technical proficiency but weak in the theoretical scientific background. Beginning in 1958 a small number of Summer Institutes specially designed for these teachers have enabled them to study the scientific subjects upon which their technical offerings are based.

B. The Training of Secondary School Teachers

1. Prior to the introduction of NSF Summer Institutes for High School Teachers in 1954 it was very difficult for high school teachers to improve their subject matter background. Most colleges or universities which offered summer courses in science or mathematics either offered beginning undergraduate courses for undergraduate repeaters, or occasionally graduate courses for which teachers, with a general background in several sciences but no strong major, were not qualified. Any of these courses which were available were particularly unsuitable for those teachers who had been away from college more than a few years, for their background was out-of-date. And colleges which did attempt to give subject matter courses suitable for teachers seldom had enough registrants, because teachers were not paid during the summer months, and so had to work at summer jobs in order to support their families. The Summer Institutes were originally designed to overcome these difficulties; they offered teachers especially-devised courses which reviewed the fundamental theories of the various sciences and the modern developments in them, and the institutes also provided support for the teachers so they could attend in groups sufficiently large to warrant offering the programs. The

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4/ "Teacher Supply and Demand in Universities, Colleges, and Junior Colleges" 1961-62 and 1962-63. Research Report 1963-R3, National Education Association (Tables D and S).

institutes provided additional advantages through special seminars devoted to classroom adaptations of the new materials, and through extra-curricular discussions among teachers from widely differing school systems. This orientation of the Summer Institutes to the study of the fundamentals of subject matter had as its purpose enabling the teacher to teach from strength of knowledge, and was an immediate success.

2. It became apparent in studying the first groups of participants at Summer Institutes that the subject matter deficiencies of most teachers of science were even greater than had been anticipated. Consequently the Foundation worked out in conjunction with two universities a new plan for Academic Year Institutes, with the purpose of training in depth, a group of carefully selected teachers who would be supported while on a year's leave from teaching. Again, special programs had to be devised because the teachers, while competent, were not prepared sufficiently to be able to take regular advanced courses -- courses which, in any case, were oriented toward the training of advanced scholars, not toward the needs of teachers for a thorough understanding of fundamentals. Because of the recognition given to teachers by their school systems -- in terms of salary increases especially -- for advanced training leading to a master's degree, the various Academic Year Institutes were instrumental in devising new degrees to be offered to teachers. These new degrees, with titles such as Master of Science Teaching, were designed to displace the Master of Education degree, and yet offer a broad program in science which was not provided by more specialized studies traditionally associated with the Master of Science degree.

3. At the same time the Foundation began a program of In-Service Institutes, designed to offer courses similar to those offered in Summer Institutes, but offered during the academic year, in the evening or on Saturdays, for the benefit of teachers who could thus carry on their regular teaching duties at the same time. An essential purpose of these Institutes was to teach many teachers who were unable to attend Summer Institutes because of family obligations or other summer commitments. These low-cost programs have the same objectives as the Summer Institutes, and differ principally in that the group learning activities resulting from the residential aspects of summer institutes are mostly lacking. On the other hand, In-Service Institutes have a more local orientation, and can be more directly related to the specific needs of local school systems.

4. For the occasional teacher with subject matter background both recent and sufficient in depth, the Foundation introduced in 1959 two advanced programs -- Summer Fellowships which enable an individual teacher to take the advanced courses offered by a few universities, and Research Participation programs permitting him to learn directly about scientific methods through activity as a research associate in a university research project. Necessarily, these programs are limited to the relatively few teachers who are well trained but need an opportunity to keep up with progress in science.

5. With the development (beginning in 1956) of massive Course Content Improvement projects such as PSSC, SMSG, etc., there has been much interest expressed by teachers -- often prodded by their supervisors and school boards -- in attending institutes which would give them appropriately oriented background subject matter. The divergence of much of these new materials from secondary texts, both in scope of material and in their experimental approaches, is such that only the best prepared teachers can change approaches without transitional help. At the same time, the emergence of these new approaches (both NSF-supported and others) has provided a natural incentive to teachers to advance their studies, even when there is not yet pressure to change curriculum, and these materials have tended to provide an appropriate focus for many institute seminars and lectures: it is estimated that approximately twenty percent of the summer and in-service institutes currently being offered have a major orientation toward one or more of the new course content programs.

C. The Training of Elementary School Teachers

Traditionally, very little natural science has been taught in the elementary grades (grades 1-6), and most of this has been rudimentary natural history. Movements in the last ten years to include more science in the elementary grades have found the teachers woefully unprepared: a majority have taken no science in college and very little in secondary school. At the same time, the teaching of arithmetic, while carried on in all grades, has been static, again due to the lack of background of most elementary teachers: many have had little high school mathematics themselves, and if they took it in college, it was probably a "regular" course unrelated to understanding the theory of arithmetic.

Beginning in 1959 the Foundation has supported a small number of Summer Institutes and In-Service Institutes for Elementary School Teachers and Supervisors, with the orientation toward the theory of arithmetic and the unifying "large" ideas of the physical, biological, and earth sciences. Emphasis has been placed on the selection of "key" teachers and supervisors who may be able to spread the influence of the programs to more than one classroom. At the same time, a primary purpose of the Institutes has been to give institutions an opportunity to try out imaginative approaches to the teaching of science to elementary teachers, with the hope that these may influence the training of prospective teachers.

II. Scope of Current Teacher Training Programs: Comparison with Estimated Needs

The history of the various institute programs is given in Table I. Perhaps the best measure of the scope is in relation to the relevant teacher populations, as follows:

A. College Teachers

Summer Institutes and Conferences and Academic Year Institutes reach annually a total of about 3,200 college teachers of mathematics, engineering, and science (including social science). This is about 3% of the estimated 110,000 teachers in these fields in universities, colleges, and junior colleges. The need of these teachers for "refresher" work may be estimated by considering that a "Sabbatical" summer every 5 years would require the availability of over 20,000 training opportunities each summer. (However, this number is probably impractically large because of the necessity for many of these teachers to teach summer school themselves.)

Of the 110,000 college teachers, approximately 6,000 were new full-time instructors in 1962-63 -- 1,800 Ph.D.'s, 3,200 with master's degrees, and 1,000 without the master's. Thus the number of new instructors without the doctorate each year is larger than the total number of training opportunities currently available for all college teachers.

Another estimate of the demand for summer institutes and conferences for college teachers appears in the 11,500 applications received for the 3,100 places available in 1963, and more applications would undoubtedly be received if institutes were offered in a wider variety of subfields of science.

B. Secondary School Teachers

The major impact of the Institutes programs through 1963 has been on the secondary school teacher group. During this time a total of 170,000 training opportunities (summer, academic year, in-service) have been made available. During the current year (summer 1963 and academic year 1963-64) there will be approximately 38,000 training opportunities utilized by 35,000 different individuals. These individuals constitute 20% of the present total group of 175,000 secondary school teachers of mathematics and science. Since institute opportunities have been provided at approximately this rate since 1959, it might appear on the surface that the field is possibly nearing a saturation point. That this is not at all the situation is reflected by the 80,000 different teachers who apply to participate in summer or in-service institutes each year, as well as in an analysis of the various purposes for which institutes are conducted.

It should be noted, first, that there is considerable overlap of individuals from one year's programs to the next, primarily because of the great need of these teachers for refresher work and advanced work in more than one area of science and mathematics. Estimates show that the 170,000 training opportunities offered to date have actually been used by not over 90,000 different individuals, so that at least half of the current teachers have never attended an institute.

The principal purposes of institutes for secondary school teachers may be divided into four categories, it being understood that some institute programs will serve different purposes for different individuals, or several purposes at once: (1) refresher work to up-date the general background of teachers who were once well prepared according to the standards of the time; (2) upgrading, for the many teachers who were never fully prepared for their present assignments or multiple assignments; (3) special updating to prepare teachers who are qualified to teach traditional texts so that they may offer new programs; and (4) advanced work so that teachers may meet the higher certification standards now required in many states.

For the first purpose, refresher work, it can be expected that a teacher should have a refresher opportunity at least once every five years for each subject taught. According to the Research Division of the NEA, 66% of secondary teachers have had at least five years' service, and approximately 40% of science and mathematics teachers are required to teach more than one subject. Thus, (175,000 x .20 x .66 x 1.4=) 32,000 training opportunities in summer or in-service institutes are estimated to be needed for this refresher purpose alone.

To estimate the needs of training to upgrade those teachers who do not meet the present established standards for initial preparation is a more difficult problem, because the standards required vary considerably from state to state. As one approach, let us consider the teachers hired for their first teaching positions -- their total deficiencies, if made up over several years, could be considered to be equivalent to the average training load required in any one year for all teachers with deficiencies, if it assumed momentarily that there is no long-term backlog of deficiency. According to estimates made by NSF, the number of new science or mathematics teachers currently entering the field each year is approximately 22,000 (17,000 as replacements and 5,000 for new positions).

However, to take a typical year, according to a recent Research Report of the NEA,5/ the number of college graduates certified to teach mathematics or science, graduating in 1962, was 14,647. The previous year, only 72% of those prepared in mathematics and science had accepted secondary teaching positions; thus, only 10,500 of the 1962 certified graduates were probably teaching during 1962-63, and the remaining 11,500 new teachers were recruited from other sources. Non-numerical surveys have indicated that most of these non-certificated teachers were recruited from groups certified in other subjects, from college graduates not certified in any subject, or from former teachers whose training is out-of-date. The amount of subject matter training lacked by these new recruits is between 6 and 30 semester hours, and is conservatively estimated at 15 semester hours average, or the equivalent of at least two institutes. Thus, the training load needed for non-certified new teachers is 23,000

5/ "Teacher Supply and Demand in Public Schools, 1963," Research Report 1963-R4, National Education Association (Table 9).

opportunities in summer or in-service institutes. To this must be added corresponding training for teachers in service who are transferred from teaching other subjects, and the backlog of undertrained teachers from former years. A rough estimate would raise the annual training needs for all undertrained teachers to at least 40,000 opportunities in summer or in-service institutes.

For the third purpose, the special updating required as background needed for teaching new curricular approaches to science, an estimate is available from studying the sales of textbooks taking these approaches. These sales are reported by Science Education News 6/ as between 400,000 and 500,000; it may inferred that at least 10,000 teachers will be teaching these materials in 1963, most of them for the first time. Another clue as to the demand for this type of training appears in the fact that in the 1962-63 In-Service Institutes and 1963 Summer Institutes, about 17,000 different teachers applied for participation in the Institutes specifically devoted to this purpose, and over 6,000 of these actually participated -- it is mainly from this group that those teaching these courses next fall will come. Projecting this apparent interest and backlog over the next several years indicates a probable need of at least 10,000 training opportunities for this purpose each year.

The fourth purpose of institutes for secondary school teachers, to provide studies in science and mathematics beyond the levels previously expected of qualified teachers, has evolved in the last several years. It reflects directly the rising requirements for certification. Both the Mathematical Association of America and the American Association for the Advancement of Science have recently adopted recommendations for subject matter requirements for teachers, which expect substantially more than previously required by most states; a number of states have recently raised the requirements for permanent certification to the level of a master's degree.

While the Academic Year Institutes have had as their purpose since their inception in 1956 the training in depth essentially equivalent to the above, the number of participants in this program has been limited to approximately 1% of the teacher population annually so as not to remove too many teachers from the schools. To provide more teachers with similar advanced training, a number of Summer Institutes and In-Service Institutes have developed sequential programs, most of which lead to a master's degree; these now constitute almost 40% of the institutes, with about 13,000 teachers participating. The number of master's degrees resulting will exceed 3,000 annually beginning about 1964. There is great demand for these sequential programs on the part of both teachers and institutions; institutions in particular find that these sequential programs fit naturally into their usual concepts of continued study. However, it has been the plan of the Foundation that the number of these sequential programs will not exceed the number of institutes oriented toward other purposes.

6/ American Association for the Advancement of Science, June 1963.

In summary, the total needs of annual training opportunities in Summer Institutes or In-Service Institutes for Secondary School Teachers are estimated as follows:

(1)	refresher courses	32,000	
(2)	upgrading the not-fully-prepared	40,000	
(3)	special updating for new curricula	10,000	
(4)	advanced training to meet higher standards	15,000	
	Total annual training opportunities needed		97,000

In comparison with these needs, we have:

Fiscal year 1963 awards	36,000 opportunities
Fiscal year 1964 (Congressional request)	36,000 opportunities
Fiscal year 1965 (tentative budget request)	45,000 opportunities

That there is actual demand for such training is demonstrated by the receipt of about 200,000 applications for the 1963 programs, from an estimated 80,000 different teachers. The ability of the university community to meet this challenge is shown by the receipt for 1963 of over 1,100 proposals in these programs, offering to provide training for over 57,000 individual teachers; in fact, many of the institutes could train an increased number of participants, but were not encouraged by NSF to increase their present offerings because of the large number of other proposals which cannot be granted.

C. Elementary School Teachers

There were approximately 1,050,000 teachers employed in 1962-63 in grades K-6, in public and private schools, and this number is growing at the rate of 30,000 per year. Of the present group of teachers, about 50,000 are teachers of departmentalized subjects; the remainder are generalists -- 850,000 teaching all academic subjects in a single grade, and 150,000 teaching general subjects in classrooms which combine several grades. It is noteworthy that 16% of all elementary teachers still do not hold bachelor's degrees (even though there has been a steady and significant improvement in this area since 1948, when 54% were not college graduates).

About 95,000 elementary school teachers of the 1962-63 total were not employed as teachers anywhere during the previous year. But only 51,000 of these came from the college class of 1962 as certified teachers. While undoubtedly some of the remainder were recruited as former teachers, a large number must have been college graduates without regular certification. Regular elementary certification in most states currently requires a bachelor's degree, with a specified minimum in number of credits in (a) professional education, (b) practice teaching, and (c) "general education," or breadth of subject matter knowledge suitable for teaching a general elementary curriculum. Some states now require that this general education include credits in mathematics and science, but this seldom is more than 6 credits of each, frequently less.

It would obviously be desirable to offer a "refresher" summer in mathematics and science -- perhaps one summer of each -- to all elementary teachers periodically, say once every five years. (For many, this "refresher" would be the first taste.) Since 77% of elementary teachers have five or more years experience, this would entail an annual minimal requirement of 150,000 training opportunities -- quadruple the present secondary school program. But it appears doubtful that there exist enough college staff to handle this job on top of their present commitments. Thus the orientation of the programs of Institutes for Elementary School Personnel has been (1) to provide up-to-date information for specialist teachers, supervisors, and other "key" teachers of science and mathematics in the elementary schools, especially in the summer; and (2) to encourage these specialist teachers and qualified secondary school teachers to conduct in-service training locally for their elementary colleagues. Such a plan would require about 100,000 "key" teachers or teacher-instructors, half in mathematics and half in science. Their training for this specific purpose, if done over a five year period, would require 20,000 training opportunities per year. This compares with 2,700 training opportunities currently offered annually for elementary school personnel.

III. Fulfilling the purpose: effects of the Institute Programs

There is a general recognition in academic and educational circles of the advantages of up-dating of teachers' subject matter backgrounds, and the Institutes programs of the NSF have been acclaimed because they have made this up-dating possible on a more regular basis for large numbers of teachers at all levels. These advantages have also been recognized by the Congress (as indicated in the introduction) with added funds voted at the instigation of Congressional committees on three separate occasions as a tangible result. Further approval by other Committees of the Congress of the objectives and formulation of the NSF Institutes program has been demonstrated in the establishment under the National Defense Education Act of 1958 of institutes in languages and guidance, supported by the Office of Education, in patterns established by law in the image of NSF institutes.

More specific effects of the Institutes programs related to the different levels of teachers participating follow.

A. Effects of Institutes for College Teachers

The opportunity for teachers in colleges, both small and large, to improve their knowledge of the recent advances of science has a direct effect upon their students, who are then better prepared to go on to graduate studies, and who are motivated to go on in increased numbers because of the recent contacts of their teachers with university science.

For those undergraduates who are preparing to become teachers, the institutes attended by their professors are the source of better instruction and up-to-date information on new course content developments. The direct effects of institutes for college teachers upon these "pre-service" candidates for the teaching profession are especially notable in the smaller institutions, many of which have as a major mission the undergraduate training of teachers-to-be.

A recent trend which may be traced partly to increased interest in science and mathematics since Sputnik, but which is also related to increased competence on the part of the faculties of undergraduate colleges, is the significant increase in the number of juniors and seniors majoring in the various sciences. An outstanding example occurs in the field of mathematics, in which the number of seniors graduating with a major in the subject has actually doubled over an interval of the last three years; there are indications that this phenomenal rate of growth may continue for several years to come.

B. Effects of Institutes for Secondary School Teachers

The most obvious effect, and the best measure, of the programs dedicated to the subject matter improvement of high school teachers has been the marked improvement in the caliber of college freshmen. Many universities have noted the sharp rise in the mathematical backgrounds of their entering students, and especially in their improved understanding of a mathematical and logical approach to the solution of real problems. Because the high school student ordinarily studies only one year of a given science, as compared with three or four years of mathematics, the effect of teacher improvement on the resulting knowledge in science on the part of the graduating high school student is not always as noticeable as in mathematics; however, there are a number of colleges which now permit some science students to bypass the beginning college course because of their superior backgrounds. Perhaps a more important effect, in the long run, has been the steady increase in numbers of students entering college highly motivated toward careers in science and mathematics. This is in great part a direct result of their increased respect for, and guidance by, the many high school teachers who have been updated and upgraded through institute participation.

An important effect of institute activities has been the renewed interest of college and university faculties in the problems of the secondary schools, and especially in the problems relating to subject matter study by teachers. There has been an increasing realization that the types of courses in science and mathematics (which have traditionally been given so as to lead the undergraduate and graduate student as efficiently as possible into a relatively narrow research capability) is not necessarily -- in fact, not usually -- the best type of course for training teachers with a breadth of knowledge and the soundest possible understanding of the fundamental ideas in a subject area. It is noteworthy, for example, that the first major activity of the Committee on the Undergraduate Program in Mathematics (CUPM) after its reorganization in 1960, was the outlining of a desirable program of secondary school teacher training in mathematics, one which is far different from the usual pattern expected for admission to graduate school. And the differences are not in quality, but in a judicious selection of courses and content oriented toward the undergraduate training of teachers, including several courses normally given only at the graduate level before. The experience with teacher training upon which this CUPM report was based emanated in large part from the activities of committee members and others in NSF institutes, and their observations concerning the needs of teachers as seen through close contact in institutes with large numbers of experienced in-service teachers. Similar experience was an important influence in the preparation of the comparable report by a committee of the American Association for the Advancement of Science recommending suitable programs for the training of teachers of high school science.

Another effect of institute participation has been to help keep teachers on the job. One factor in this has been the credit which many have earned, in their subject fields, which removed deficiencies in their certification requirements. A second factor has been the increased salary resulting from advanced training. A third, perhaps considerable, factor has been the basic summer income provided in the form of stipends which has enabled a number of teachers to support their families during the unpaid summer months rather than succumb to the throughout-the-year incomes of other occupations.

In contrast with enabling a number of secondary school teachers to remain in teaching through increased qualifications and increased income, a rather unexpected effect of participation in institutes (especially Academic Year Institutes and extended sequential programs) has been the annual transfer of several hundred secondary school teachers to positions in junior colleges and colleges. In this, in-service programs have in actuality served as pre-service training for a new occupation. With the current shortage of college teachers, especially in the smaller or less affluent institutions, this retraining has been a real asset, even though it has caused corresponding losses to the high schools.

A number of high school teachers who have received advanced training in institutes, and frequently a master's degree, have been recently employed in their home localities as instructors in in-service training activities for elementary school teachers. Noteworthy in this connection have been statewide programs in Maine, Vermont, Montana, and Idaho. The best qualified "graduates" of institutes for secondary school teachers, as their numbers increase, will become an increasingly important manpower pool capable of providing in-service training in science for the vast numbers of elementary school teachers -- too vast for the available college faculty manpower.

C. Effects of Institutes for Elementary School Teachers and Supervisors

The very limited size of this pilot program has necessarily restricted its effects in quantity, but the four years of operation have resulted in an increase in the substantive knowledge of over 5,000 key teachers. The scientific background gained by these key teachers has influenced the science education programs in schools and entire school systems, either through direct teaching by these teachers as "specialists" in science or mathematics, or through curricular changes and in-service training efforts.

At the same time, these pilot institutes have provided the necessary testing grounds for experimental courses for the training of elementary teachers of the natural sciences, and in mathematics have begun the massive task of improving the teaching of arithmetic through better understanding of the structure of the number system.

IV Relationship between Pre-Service Training and In-Service Training Programs

In the previous section we have outlined a number of effects which the Institutes programs for in-service teachers have had upon the pre-service training of prospective teachers (especially those preparing for the secondary level). In summary these are: direct improvement of teaching in the institutions principally concerned with pre-service teacher training through participation of their faculty members in institutes for college teachers; modifications in courses for prospective teachers because of experience of college faculties in offering institutes to experienced teachers who are responsible critics of these courses; and changes in curriculum patterns for teacher training recommended by CUPM, AAAS and others, based on experience in institutes. In addition, six Academic Year Institutes have experimented with direct adaptation of their offerings for small groups of pre-service teachers at the graduate level, and a number of Academic Year Institutes and In-Service Institutes have made some of the special courses of their Institute offerings available to undergraduates in training. But perhaps the greatest effect of the institute programs upon the pre-service training programs has been the greatly increased interest of members of college faculties in the problems of the secondary schools and secondary school teachers generally.

The question has often been raised as to whether the Foundation should not devise and initiate efforts to improve the pre-service training of teachers and to increase the number being trained. There is considerable hope that a program of support for undergraduate courses in science and mathematics could improve these courses, and that this support might increase the number of students enrolled in teacher-training curricula, especially if some support incentive were offered to the students. But this does not imply that the students graduating from these programs would become teachers in greater numbers than at present. Rather, fundamental changes must be made in the general salary levels for teaching to attract more graduates into the field, and it is probable that increases in salary and career prospects might attract more candidates quite independently of changes in the undergraduate curriculum.

It is, of course, quite possible that support for undergraduate teacher-training programs would tend to effect some improvement in the quality of the output. For this reason, there should be more consideration given to experimental projects of this kind, and to research and analysis efforts in the general area of the subject-matter training of teachers.

Today teacher-training programs are recognized as having four components: professional education courses, practice teaching experience, general education in the liberal arts, and preparation in a major subject-matter field. The latter two of these components have been the subject of increasing consideration in the last decade and in particular that component which is of direct interest to the Foundation -- the scientific content of the major subject fields. An accumulating impact is now being felt as a result of improvement of college faculty members providing instruction in these subjects through participation in NSF fellowship and institute-type activities. In addition the impact of the recommendations of the Committee on the Undergraduate Program in Mathematics is growing, as will recommendations of the various other study groups which are now formulating ideas for assuring preparation in the several subject-matter areas. These efforts, while having a minimal direct interference with the prerogatives of colleges in determining their own programs, are recognized as having considerable effect on the training of all undergraduates. This is attested to by the fact that several non-science groups are now investigating the application of similar techniques to such areas as social studies, humanities and English.

It is significant, too, that any direct approach to improvement in the training of new teachers which would ignore the problems of supplementary training for the existing corps of teachers would not produce significant results in the training of students in science in the near future. In the first place, the number of new teachers entering the field (whether secondary, elementary, or even college teaching) is only about 6% per year. Also, these new teachers necessarily enter at the bottom of the profession, and are not in a position to be influential in changes of curriculum and content until they achieve greater seniority and experience. In the meantime, educational policies are set and the "best" sections are taught by the more experienced members of the staff. Thus, immediate results can be obtained only by paying major attention to the needs of the experienced teachers. In consideration of the numbers of individuals involved, it thus is clear that training efforts directed toward the in-service group of teachers can have more immediate and more effective impact than efforts directed toward improving the initial training of new-comers to the field, important as this latter aim is. These efforts to improve the subject-matter knowledge of those now teaching will have as important secondary benefits the improvement of pre-service training, as detailed above.

V Projected Scope and Orientation of Teacher-Training Programs: A Summary

The foregoing discussions all lead to one conclusion: the Institutes programs of the Foundation are making a most significant impact upon education in the sciences and hence upon the scientific potential of the nation. These programs should be continued, and expanded in an orderly fashion to the extent that national resources and manpower resources allow. The necessity for this continuation, and the magnitude of expansion, are determined by means of the following parameters: (1) the needs of teachers for subject matter improvement, which are far greater than current offerings; (2) the requests on the part of teachers for the opportunities to participate in institutes, which are of the same order of magnitude as their needs; (3) the available resources of instructional staff and faculties, which are still at least double the present program size, as measured by acceptable proposals received; and (4) the capabilities of educational institutions to do the job, as measured by the increasingly high quality of institutes in operation.

The principal variable elements in future program planning should concern the balance between various types of institutes -- summer, in-service, and academic year. The programs for secondary school teachers, as a whole, should continue to operate at as high a level as resources allow. There is an increasing need for major expansion of the programs for college teachers as the current boom in college enrollments continues. And the programs for elementary school personnel should be expanded along those particular avenues which promise to provide the best multiplication effect at minimal cost.

While maintaining and enlarging the existing programs to the extent that funds can be allocated to them, experimental efforts should be carried forward in several areas: (1) development of programs to bring into teaching capable college graduates who are working at less-essential tasks or who are not now working; (2) research and analysis in the problems of training science teachers; and (3) additional improvement of subject matter for undergraduates in pre-service training curricula, through such devices as summer institutes emphasizing the newer course content materials for college juniors and seniors.

STAFF PAPERS RELATED TO EVALUATION OF INSTITUTES

NORTHROP, E. P.
"Reports and Reflections Concerning Institutes for High School and College Teachers of Mathematics and Science Supported During the Summer of 1954 by the National Science Foundation and the Fund for the Advancement of Education," October 1954.

AUTHOR UNKNOWN
"Staff Study of a Training Program for High School Teachers" - (Academic Year Institutes), July 1955.

CAMPBELL, J. ARTHUR?
"The Future of the Institutes Program of the National Science Foundation," January 22, 1957.

HAUSMAN, HOWARD J.
"Evaluation of the 1957 Summer Institutes: Summary of Visits by Staff Members, Divisional Committee Members, and Contract Panelists," November 1957.

HEMILY, PHILIP W. and REYNOLDS, THOMAS D.
"Institutes for Elementary School Teachers and Supervisors," July 3, 1958.

BUCHTA, J. W.
"Staff Paper on Institutes," February 3, 1959.

MILES, E. P., JR.
"The Role of the National Science Foundation Summer Institutes Program in the In-Service Training of Secondary School Mathematics Teachers - A Spring 1959 Study," May 29, 1959.

YOUNG, ALBERT T.
"Sequential Summer Institutes - Analysis of Informal Questionnaire," January 19, 1960.

PINO, L. N. and PHELPS, C. RUSSELL
"The Academic Year Institutes Program: An Evaluation," August 15, 1960.

BENNINGTON, NEVILLE L.
"Sequential Institutes," November 28, 1960.

BENNINGTON, NEVILLE L.
"Multi-Term Project Support," November 29, 1960.

ANDERSON, ROBBIN C.
"The Future Role of Institutes," February 14, 1961.

YOUNG, ALBERT T.
"Summary of Visitation Reports, Institute Section Programs, FY 1959-1961," October 1961.

BURNS, GEORGE; ESTEES, CHARLES; MAXWELL, HOWARD; and YOUNG, ALBERT
"National Science Foundation Institutes Section" - (History and current status (1961) of Institutes), January 1962.

WAY, HAROLD E.
"Local Orientation of Institutes" - (Local vs. National Summer Institutes), April 22, 1963.

PHELPS, C. RUSSELL
"Orientation, Purpose, and Scope of NSF Teacher Training Programs," July 25, 1963 (See Appendix ____).

CARNELL, PAUL
"Evaluation of the Countrywide Academic Year Institutes Program, Summary of the Special Reports from Veteran Directors," November 1964.

WAILES, JAMES R.
"History and Development of National Science Foundation Institutes for Elementary Teachers," (Draft; to be published Fall 1967).

Reports Prepared Under Contract

Number	Date of Report	Title of Report
C-39	1956-January	The National Science Foundation Summer Institutes of 1955: An Evaluation-BSSR
C-39	1956-December	The National Science Foundation Summer Institutes of 1955: Forty-One Participants Express Their Views a Year Later-BSSR
C-44	1957-April	The National Science Foundation Summer Institutes of 1956: How 1,100 Participants Responded to a Questionnaire-BSSR
C-62	1957	The Professional Qualifications of Applicants to the 1957 Summer and Academic Year Institutes-CEIR
C-55	1957-December	Evaluation of the National Science Foundation Summer Institutes Program-SRA
C-124	1960-June	A Follow-Up of 1957 Institute Participants Volume I - Report and Interview Schedules Volume II - Appendix Tables - BSSR
	1961-September	A Review by Dr. Marsh W. White
C-158	1961-May	Analysis of the Applicant Record Cards Submitted to the 1960 Summer Institutes for College and Secondary School Teachers and Elementary School Personnel and the 1960-61 AYI for Secondary Teachers-Blanche & Ass
C-159	1961-August	A Study of the Attributes of Applicants to the Natio Science Foundation Institutes in 1960 - SRA
C-222	1962	A Study of Non-Applicants and Other Segments of the Secondary School Science and Mathematics Teacher Population - SRA
	March	Preliminary Findings
	November	Final Report and Technical Appendices
C-215	1964-August	Summary of the Applicant Record Cards Submitted to the Fiscal Year 1961 NSF Institutes, Conferences, and Research Participation Programs - Blanche & Associates
C-273	1964-October	Summary of Applicant Record Cards Submitted to the Summer 1962 and School Year 1962-63 NSF Institutes, Conferences, and Research Participation Programs - Blanche & Associates
C-273	1964-October	Summary of the Applicant Record Cards Submitted to the Summer 1963 and School Year 1964-64 NSF Institutes, Conferences and Research Participation Programs - Blanche & Associates
C-349	1965-August	Attributes of Applicants to NSF Summer Institutes in 1964 (Final Report and Appendix)-Psychometrics Consultants
C-351	1965-April	An Investment in Knowledge, A Study of the National Science Foundation's Summer Institutes Program by Hillier Krieghbaum and Hugh Rawson - New York Universit
C-486	*1967	Attributes of Applicants to NSF Summer Institutes in 1964 (Supplement to the Study) - Psychometrics Consultants

* Not yet completed

C-39 January, 1956
The National Science Foundation Summer Institutes of 1955: An Evaluation --
Bureau of Social Science Research.

The Foundation wanted a short-term evaluation study that would bring forth some tentative estimates of the immediate effects of the institutes on the participating teacher. The program administrators also wanted to gather information on participants' expectations of future effects of the institutes. Since these opinions were the best estimates available, they seemed the logical starting points for the design of meaningful follow-up studies.

The report was developed around questionnaires administered to participants before and after their participation in the 1955 summer institutes. There were 364 respondents out of a total sample of approximately 400. Topics covered by the questionnaires were background characteristics, expectations of benefit from institute attendance, expected use of their experiences, expressions of satisfaction and dissatisfaction, and suggestions for changes or improvements of future institutes.

The study concluded institutes rendered immediate and short-range benefits to those who attended. Although they had not expected it, the most important benefit to the majority of participants was learning subject matter. The participants who had expected benefits in teaching techniques information were disappointed. Many of the participants benefited by the professional-social contacts, some to the extent of professional advancement; this was true especially among the college teacher participants. Most participants were amazed at the psychological benefits, which ranged from newly-acquired missionary spirit to grateful acknowledgements for having been shocked out of complacency. The high school teacher group derived considerably more satisfaction and benefits from the offerings of joint high school-college institutes than their colleagues on the college level.

Nine out of ten of the participants expected to utilize their experience -- the majority thought in the actual practice of teaching; others anticipated having the opportunity or duty of bringing about administrative changes; some expected professional advancement; and a few would transmit some of the newly-gained knowledge to their colleagues back home.

As a sidelight of the study, it was found that most participants learned of the institute from printed matter addressed directly to them, such as publicity material from the host university or press releases published in professional journals to which participant subscribes.

C-39 December, 1956
The National Science Foundation Summer Institutes of 1955: Forty-one Participants Express Their Views a Year Later -- Bureau of Social Science Research.

This was stage two of the evaluation of the 1955 Summer Institutes. The study was based on interviews of a carefully selected sample of 42 of the original 364 respondents. The purpose was to obtain qualitative indications of changes which occurred in the teaching habits of some of the participants in the course of the academic year following the institutes.

The results clearly showed that the immediate and short-range positive impact of institute experience was carried over into the subsequent academic year; the teacher-participants made practical use of what they had learned at the institute. The majority applied their institute experiences in the course of their teaching activities and many noticed that they did a superior job with their laboratory assignments. Some attributed their stimulation to start science fairs or exhibits of interest, their improvement in student counseling and guidance, or their professional advancement to the fact they had participated in the NSF summer institute. A few teachers were given administrative assignments in which they could draw on their newly-acquired knowledge, and some were able to transmit some of the newly-acquired knowledge to their colleagues on the faculty. Many had continued to communicate throughout the year with the institute faculty members and most of them expressed a desire to attend future institutes. The predominant characteristic of the responses of the participants was that of satisfaction and enthusiasm.

C-44 April, 1957
The National Science Foundation Summer Institutes of 1956: How 1,100 Participants Responded to a Questionnaire -- Bureau of Social Science Research.

The favorable reception of the 1955 institutes led to further expansion of the Program in 1956. Therefore, it was felt by the program administrators that the objective evaluation of the Program must be continued. The experience gained from the 1955 evaluation was taken as a basis for the evaluation of the 1956 institutes. The study was based upon answers obtained from a multiple-choice questionnaire distributed to the participants in the 1956 summer institutes. It explored in more detail the "pre-institute" stage as seen from the point of view of the eventual participant, how he learned about the given institute, what features of the institute particularly attracted him, what factors he considered in his decision to attend the session. The study also obtained an overall evaluation of the participant's institute experience and elicited opinions on other types of institutes which the respondent would consider valuable.

The results showed the majority of all participants learned of the institute between February and April from printed matter mailed directly to them, such as publicity material from the university (institute) administrations or press releases published in professional journals to which the respondent subscribed (there was surprising variation among the academic disciplines). The remaining participants learned through informal channels (conversation with colleagues, letters from friends, etc.); from reading their newspaper; or through notices addressed to their school or superior. Standard mass media (newspaper and television) were suggested by a few participants as potential means of communication to reach teachers.

Most participants decided to apply to the institute within a week after learning of it. The feature that attracted the majority was the description of the scheduled subject matter as stated in the information materials. Some participants were attracted by the way the institute was going to be organized, the information that was to be presented in regard to teaching techniques, the names of the institute lecturers, the facilities or equipment available to the institute, or the location of the institute.

The factor that was most important to the participant in deciding to attend the institute was whether he would receive a stipend. Second most important consideration to high school teachers in general was whether academic credit would be offered for attending the institute; to the chemists and physicists was the problem of fitting the institute into the family summer schedule. Approval of superior was important more frequently among college than high school teachers and among the astronomers.

Participants had definite ideas as to what other types of institutes should be established to aid science education in this country. Joint workshops or conferences for both high school and college teachers were needed. The high school teachers as a group expressed top preference for full-year institutes whereas their college colleagues would rather have special institutes for the science teachers in teacher colleges. Many participants advocated as most urgent the establishment of institutes in science for elementary school teachers.

C-55 December 1957
Evaluation of the National Science Foundation Summer Institutes Program - Science Research Associates.

As the Summer Institute program increased in size, it became increasingly important to the Foundation to know factually and objectively how well they had actually functioned a) to help high school teachers keep abreast of scientific knowledge, and b) to encourage colleges and universities in their efforts to train science and mathematics teachers. How well did the Summer Institutes perform in terms of the $5 million now being invested in them? How well did the host colleges and universities -- as a whole -- appear to be conducting the Institutes?

The study embodied two phases: Phase I, an interview study of 277 high school teachers who participated in 1956 summer institutes and of about one-third of the supervisors of the teachers interviewed; and Phase II, an "on-site" evaluation of the summer institutes held in 1957. Also, a mail questionnaire was sent to each of 627 stipend-receiving teachers who had attended a summer institute in 1956.

The conclusion drawn from the findings was that Summer Institutes had served as an effective, if still, minor, catalyst in science education. Their strongest apparent benefit had been that of bringing participating teachers up to date in their knowledge of recent scientific advances. They had been of almost equal value as a professional stimulant, arousing in teachers a renewed enthusiasm for their subjects. It was found that they had been of considerable practical value in providing the teacher-participants with entirely new ideas for presenting subject-matter material.

They had also been of considerable benefit to the colleges and universities. From special, new courses developed for use in the Institutes themselves, many of these institutions had gone on to make and to plan changes in their own regular teacher-training curricula.

C-62 1957

The Professional Qualifications of Applicants to the 1957 Summer and Academic Year Institutes - Corporation for Economic and Industrial Research.

Since the Foundation was to support approximately 5,600 teacher-participants in the 1957 summer and academic year institutes combined (for a total of $10 million), the program administrators wanted an indication of the quality of the applicant and of the kind of teacher making application to these institutes. To discover these characteristics, this study made statistical analyses of the application forms submitted by the teachers in applying for stipends to the 1957 Summer Institutes and to the 1957-58 Academic Year Institutes. The application forms of all participants, all applicants who were accepted but withdrew, and a random sample of the applicants who were rejected, were included in the analyses. The characteristics analyzed were academic preparation (degree and major subject), credit hours and grades (undergraduate and graduate), major teaching fields, employment record, previous institute attendance, and organizational membership.

The analyses showed that ninety-nine percent of all applicants had a bachelor's degree. Most applicants' major teaching field was a combination of mathematics and science; this was true of all institutes, general or specialized, including the mathematics institutes. Correspondingly, at time of application, most applicants were teaching a combination of mathematics and science, very few taught physics, chemistry, or biology exclusively, even at the institutes which specialized in those subjects.

The acceptees of 1957 had more undergraduate and graduate credits in every subject listed than did the rejectees of that year. A bias toward science and mathematics and against education or non-science as a major for the bachelor's degree was observed. However, selection appeared to favor those with master's degrees as the highest degree earned. Generally, there were more rejected than accepted applicants whose major teaching field was non-science and science or non-science only. The percentage who taught both chemistry and physics was lowest among the rejected applicants. Otherwise, acceptees and rejectees did not differ from each other in major teaching field or employment record. Journal reading, particularly in a special science, was in the applicant's favor, as was membership in education or education and general science organizations. There was also some evidence that previous institute attendance was more typical of the accepted group.

C-124 June, 1960
A Follow-Up of 1957 Institute Participants--Bureau of Social Science Research.

The initial design was to study the long-range effects produced within and around the teachers who had attended a summer institute as compared with a control group of teachers who had never attended one. Conclusions were to be based upon interviews conducted in the fall semester 1959/60 with those high school teachers who had participated in the 1957 summer institutes, with their colleagues who were non-participants in terms of NSF programs, and with their supervisors. However, as the study progressed, it became evident from the information collected that the basic groupings for the analyses had to be refined because some of the participants had attended more than this one summer institute.

On the whole, the survey evidence clearly indicated that the summer institute programs were attaining their announced objectives to a satisfactory extent. It was shown that the institute attenders were preferred above their non-attending colleagues in their assignments to teach new courses, their modifications in existing courses, changes in subject matter, and the use of new teaching techniques. In the realm of teacher-student relations there was evidence that (1) the students performed more effectively in the classes of institute attenders; (2) better than average students went into the elective classes of the institute alumni; and (3) manifested student interest was higher in the classes of teachers who had attended NSF summer institutes. A positive correlation existed between the number of institutes attended and net differences in improved student performances, student outside reading, higher standards, and increased voluntary efforts by students.

The most significant result of the study was the fact that some of the participants had attended more than one summer institute and the increase in their teaching effectiveness was clearly related to the number of institutes attended. (It was this result that gave the Foundation the basis for planning sequential institutes.) The multiple attenders showed impressive advantages over their once-only colleagues in respect to their application of what they had learned to actual school conditions. Decided advantages were shown in direct effects such as in teaching subjects not previously taught, teaching more advanced sections, improving teaching methods, changing course content, increased student participation, more time given to laboratory work, and additional use of audio-visual aids; and indirect effects such as addresses to faculty about institutes, adoption by other teachers of new subject matter learned by institute attenders, etc. In all of the categories triple attenders showed noticeably higher proportions of positive answers than alumni of a single institute.

C-158 (Summer 1960 and academic year 1960-61) C-158
C-215 (Summer 1961 and academic year 1961-62) C-215
C-273 (Summer 1962 and academic year 1962-63) C-273
(Summer 1963 and academic year 1963-64)
Summary of the Applicant Record Cards (Fiscal Years 1960-64) - Ernest E. Blanche and Associates.

At a NSF evaluation committee meeting in 1959 it was suggested that one way the Foundation could do follow-up studies on the participants who attended institutes was to maintain a master file containing each person's name and address. A form the size of an IBM card was developed. Starting in 1960 each applicant applying to an institute program was required to fill out one of these cards and return it via the project director to the Foundation. The applicant was required to give such information as name; date of birth, Social Security number; name of institution, city and state where employed; major level of assignment; major assignment; and subject-matter assignment. The project director noted on the card whether the applicant was accepted or rejected to his institute before returning it to the Foundation.

From these applicant record cards master rosters of the participants were prepared. In addition, analyses of the data obtained from a card submitted were made and the characteristics and distributions of the applications, applicants and participants were summarized by program by level of teaching assignment.

These rosters and summaries proved invaluable in the general administration of the Institutes Programs.

C-159 August 1961
A Study of the Attributes of Applicants to the National Science Foundation Institutes in 1960 - Science Research Associates.

The Foundation wanted to discover what factors, if any, were widely characteristic in determining the selection or rejection of applicants to each of the three broad institute programs (summer, academic year, and in-service). Were the applicants, acceptees, and rejectees the same or was there any significant group of people not being serviced from among those applying?

The study undertaken developed its results from the analyses of the data compiled from the biographical information found in 16,000 completed 1960 institutes' application forms. Random samples and, in some cases, total groups were selected from the accepted and rejected applications of each teaching level represented in the three types of programs. Differences between accepted and rejected groups were tested for significance. In addition, a comparison of the data obtained with similar data from the 1957 CEIR study was made to determine if the potential clientele was changing and, if so, in what manner. From the analyses the following conclusions were drawn:

In programs for high school teachers it was evident that undergraduate preparation in science or mathematics, and high grades in these subjects, were in the applicant's favor. However, in the summer institutes, those with the bachelor's degree as the highest degree earned were being accepted with more frequency than would be expected by chance, while the reverse was true for those with the master's degree. This fact, coupled with the observation made in the comparison of the 1960 with 1957 data that the differences between mean number of credits of the accepted and rejected groups were smaller in 1960 than in 1957, leads to the inference that a balance is being achieved in the selection of applicants with varying degrees of academic preparedness.

Predictably, the elementary teacher applicant was education-oriented rather than science-oriented. Mean undergraduate grade-point averages were higher among the acceptees. In the summer institutes, having earned a master's degree appeared to be significantly in the applicant's favor. (It appears that academic preparedness was more of an influence in the selection of elementary teachers than of high school teachers at summer institutes.)

The sample of college-teacher applicants was so small, a clear delineation of the characteristics that distinguished the accepted from the rejected group could not be observed. High achievement in terms of grades in physics, mathematics, and education, and an emphasis on education courses were characteristic of the accepted group in the academic year institutes. High academic achievement in terms of highest degree earned and number of graduate credits in mathematics was characteristic of the accepted group in the summer institutes.

C-222 March 31, 1962 C-222

A Study of Non-Applicants and Other Segments of the Secondary School Science and Mathematics Teacher Population (Preliminary Findings) - American Institute for Research.

Although some 89,000 opportunities for study in various institute programs had been provided for secondary mathematics and science teachers by the end of the 1960-61 school year, NSF personnel felt that a sizable portion of the target population had not yet been motivated to apply to an institute. This seemed particularly important since analyses of the applications indicated that a substantial portion of these study opportunities represented repeat attendance by some of the same teachers.

This study was designed to obtain information about the non-applicant for these programs as contrasted to applicant-rejectees and applicant-attendees. Data was sought concerning biographical information; training and education; professional activities, attitudes, needs, and motivations; and relevant school and community characteristics. Analyses were designed to provide information about non-applicants which might be significant for program improvement and possible modification.

As compared with the applicant, the non-applicant tended to be less well trained in terms of number of credit hours in science and mathematics subjects, both graduate and undergraduate. Although he had about an equal number of years' experience in teaching, the non-applicant tended to be less satisfied with his job, and he engaged in significantly fewer professional activities such as reading journals, holding offices, and belonging to professional societies.

The approach of the non-applicant to teaching was found to be different psychologically from that of the applicant. Although all teachers reported finding their greatest satisfactions growing out of the student-teacher relationship, the evidence suggested that non-applicant teachers derived relatively greater satisfaction from their interpersonal relationships with students and relatively less from their subject-matter activities. At the same time, they reported that their students' attitudes toward education and science tended to be less favorable. The non-applicant also tended to be more self-oriented, finding comparatively more satisfaction in personal growth and development as a teacher.

The non-applicant appeared to be a more passive personality. While he often recognized his need for better subject-matter preparation, he seemed less able to translate this need into action. Non-applicants noted that they preferred to keep up with developments in their fields by reading rather than attendance at workshops, institutes, or similar events (even though the evidence showed conclusively that they read less than did applicants). This preference for passivity ties in well with their previously-mentioned lower level of professional activities and also with the fact that comparatively fewer of them participate in organized summer activities of either professional or non-professional character. This finding is further supported by their tendency to give the vague response "other obligations" as their main reason for not applying for NSF programs.

C-349 August 1965
Attributes of Applicants to National Science Foundation Summer Institutes in 1964 - Psychometrics Consultants.

By the summer of 1964 the Summer Institutes' Program was supporting over 24,000 elementary, high school, and college teachers of science and mathematics. The programs attracted approximately 200,000 applications. The Foundation wanted a description of these applicants in terms of personal characteristics, educational background, and professional experience and interests. It also wanted to discover the differences, if any, between the accepted and rejected applicants on these characteristics.

To arrive at these objectives, the study analyzed 9,600 application forms completed by accepted and rejected applicants to the summer institutes for elementary school, secondary school, and college teachers in 1964. The analyses were designed to provide tabulations of the various responses to the questions on the application forms; to describe the central tendencies and distribution characteristics of the accepted and rejected groups at each institute level studied; to examine for significance the differences, if any, between the accepted and the rejected groups at each institute level studied; to compare the various institute levels in terms of the attributes of acceptees and rejectees in each; and to compare the high school teacher summer institute applicants in 1964 with those in 1957 and 1960.

The report consists of two volumes, Final Report and Appendix. The Appendix contains the tables that show the frequency distributions of each response to each question studied on the application form. Separate distributions were made for acceptees and rejectees within each sample studied. The main body of the report is contained in the Final Report; it presents the findings of the study and discusses all significant results.

From the results of the analyses it was concluded that acceptees and rejectees did not differ dramatically from each other except for the educational variables. A rather consistent finding was that the higher the total number of undergraduate and/or graduate credits in the various sciences, the greater was the probability of being accepted. Credits in specific sciences also appeared to favor selection in several cases. This was particularly true of chemistry undergraduate credits, and for biology, physics, and earth science graduate credits.

The acceptees usually had higher grades than the rejectees. The acceptees to the secondary sequential institutes had higher grade-point averages than their colleagues to the unitary institutes. The highest undergraduate group grade-point averages were found for the high level college institutes. Graduate grades did not appear to have been used as a selection factor as strongly as undergraduate grades except for the elementary, secondary sequential high, and college high institutes groups.

With respect to major subject for university degrees, it appeared applicants to secondary and college institutes whose undergraduate preparation emphasized science or mathematics had significantly better chances of being accepted than if their preparation was largely in educational methods. For the most part, major subject for advanced degrees was not an important factor.

A science or mathematics orientation in professional activities and professional interests also was advantageous to the applicant.

C-351 April 1965 C-351

An Investment in Knowledge, A Study of the National Science Foundation's Summer Institutes Program, by Hillier Krieghbaum and Hugh Rawson - New York University.

Summer Institutes had been in existence for 10 years. As a follow-up of a suggestion made at the Palo Alto Divisional Committee meeting, the Foundation contracted with New York University to write a summary of the program. The book-length report was to be largely historical in nature but also was to include an evaluation of the impact of the program. In addition, it was to discuss other NSF educational activities as they related to the Summer Institutes.

The book has not yet been published but the chapter evaluating the impact of the Summer Institutes program, Chapter 16, is included in this report (see Appendix F).

C-486 * 1967 C-486

Attributes of Applicants to National Science Foundation Summer Institutes in 1964 (Supplement to the Study) - Psychometrics Consultants.

This study is a direct follow-up of the studies and reports previously made under Contract C-349, and is based upon the same source materials and records. Upon examination of the previous studies, the Foundation staff felt too many variables were cancelling out many significant data that tended to distinguish acceptees from rejectees. It seemed more useful to study the differences between the acceptees and rejectees of the same discipline only. Therefore, the secondary school applicants were regrouped according to the subject dominating their weekly teaching schedules at time of application and the relationships between extent of university training received in the subject currently taught and the following educational and professional variables were measured: kind of institute to which application was made; city, state and region where applicant taught; teaching experience in biology, mathematics, chemistry, physics, earth science, and general science; highest degree earned; major for the bachelor's and master's degrees; undergraduate and graduate credits and grades in the subject currently taught; and previous attendance at NSF institutes. Acceptees and rejectees within each of the above-named groups were compared on each of these variables. In addition, a study was made to measure the relationship between extent of undergraduate university training in the subject currently taught and the above educational and professional variables. Employing the groupings used in the original study, the effect of the distance from the applicant's home to institute to which he applied was measured. (The data from the 9,600 punched cards used in the original study was transferred to data tape.)

Although the results of the analyses are not yet known (the report is only partly finished), the staff hopes it will be able to learn the absolute facts about the teacher preparation of the 1964 applicant, acceptee, and rejectee to the Summer Institutes. This would be extremely valuable information to know in administering the program the coming year.

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* Study not yet completed.

INDEPENDENT STUDIES RELATED TO EVALUATION OF INSTITUTES

BEGLE, E. G.
"NSF Summer Institutes - Evaluation", Manuscript, April 1959.

BIESTER, JOHN L.
"Report on Post-Institute Participant Evaluation", Manuscript, April 18, 1962.

BREKKE, G. W.
"A Follow-up Study of the Effectiveness of NSF Science and Mathematics Institutes for Secondary Teachers in Meeting Stated Goals", Dissertation Manuscript, January 1964.

CAMPBELL, C. D.
"An Advanced Physical Geology Course for High School Teachers", Journal of Geological Education, Vol. 8, No. 1, 1-5, Spring 1960.

COLE, JAMES W.
"Teaching Teachers of the Sciences and Mathematics", University of Virginia Newsletter Vol. XXXVI, No. 7, 26-28, March 15, 1960.

DALY, JOSEPH LaVERNE
"An Evaluation of the Second Academic Year Institute University of Utah, 1958-59", Dissertation Manuscript, August 1959.

DWIGHT, LESLIE A.
"Study of the Data on Applications to NSF Summer Institute in Mathematics for 1960", Manuscript, May 1960.

GALLENTINE, JERRY L. and BUELL, ROBERT R.
"A Study of Science Preparation of Ohio Elementary School Teachers Applying for NSF Institutes", School Science and Mathematics, 66, 573-574 (1966).

GREULACH, VICTOR A.
Personal Observations About the AYI Program - from letter dated May 16, 1960 to Dr. Lewis N. Pino.

GREULACH, VICTOR A. and CAMERON, E. A.
"Some Data on NSF 1957 Summer Institutes for High School Teachers of Science and Mathematics", Manuscript (c. 1957).

GRUBER, HOWARD E.
"Science as Doctrine or Thought? A Critical Study of Nine Academic Year Institutes", Journal of Research in Science Teaching, Vol. 1, 124-128 (1963).

GRUBER, HOWARD E.
"Science as Thought: A Study of Nine Academic Year Institutes Training of Science Teachers", University of Colorado Behavior Research Laboratory Report No. 16, May 196

GRUBER, HOWARD E., BRADY, KIRK P. and MEANS, JOHN R.
"Toward the Improvement of Science Teaching: An Evaluation of the First Academic Year Institute University of Colorado, 1957-58", University of Colorado Behavior Research Laboratory Report No. 9, November 1959.

HARRISON, EDWARD L.
"National Science Foundation Institutes". American Journal of Physics, Vol. 28, No. 3, 284-286, March 1960.

HELDER, R. J.
"Report on a Tour of Several Radiation Biology Summer Institutes for High School Teachers, July-August 1959", Manuscript (c. 1959).

HENNON, NEIL
"A Survey of Non-Applicants, Successful Applicants and Unsuccessful Applicants for National Science Foundation Summer Institutes for High School Teachers", Dissertation Manuscript, December 1961.

KOELSCHE, CHARLES L.
"Characteristics of Persons Submitting Applications in 1962 for Participation in NSF Institute Programs at the University of Georgia", Science Education, Vol. 48, No. 1, 31-36 (1964).

LANCASTER, FLOYD WILLIAM
"A Follow-up of Participants in Mathematics Summer Institutes Programs Held in Iowa in 1959", Dissertation Manuscript, June 1962.

LEE, ADDISON E.
"The Block of Time Idea in Biology Laboratory Instruction", The American Biology Teacher, Vol. 22, No. 3, March 1960.

LOWRY, WILLIAM C. and REDFIELD, DAVID D.
"Selection of Academic Year Institute Participants at the University of Virginia", The Mathematics Teacher, Vol. LIII, No. 4, April 1960.

MALLINSON, GEORGE G.
"The Summer Institute Program of the National Science Foundation", School Science and Mathematics, 63, 95-104 (1963).

MARKHAM, SISTER MARIA CLARE
"An NSF In-Service Institute for Teachers of the Primary Grades", School Science and Mathematics, 62, 403-409 (1962).

THE MATHEMATICAL ASSOCIATION OF AMERICAN COMMITTEE ON INSTITUTES
"A Conference on Mathematics Curricula in Institutes", American Mathematical Monthly, Vol. 68, No. 1, January 1961.

McBRIEN, VINCENT O.
"Survey of Participants of 1964-65 In-Service Institute in Mathematics at the College of the Holy Cross", Manuscript, April 1966.

McINTOSH, J. PAUL
"Opinions and Attitudes of National Science Foundation Program Participants", Dissertation Manuscript, May 1957.

MERRILL, GEORGE WYNN
"An Appraisal of the Post-Institute Performance of the Academic Year Institute Participants from the University of Utah", Dissertation Manuscript, August 1960.

O'DELL, CLAUDE EDWARD
"A Study of Secondary Teachers of Science in Eleven Southern States to Determine the Importance of Basic Undergraduate Courses in Atomic Energy and Space Science", Dissertation Manuscript, August 1962.

ORR, DAVID B. and YOUNG, ALBERT T., JR.
"Who Attends NSF Institutes?", The Science Teacher, Vol. 30, No. 7, 39-40, November 1963.

OSTLUND, LEONARD A.
"A Scientific Evaluation of a Scientific Program", School Science and Mathematics, 59, 207-218 (1959).

OSTLUND, L. A.
"Field Survey Academic Year Institute Participants for 1956-57, 1957-58", Manuscript, 1960.

PARKER, ALWIN
"A Study of Certain Aspects of Eight National Science Foundation Summer Institutes for High School Science Teachers Conducted in Louisiana", Dissertation Abstracts, 21, No. 9, 2537-38 (1961).

PARMLEY, THOMAS J.
"A Report on an Academic Year Institute at the University of Utah for the Supplementary Training of Secondary School Mathematics Teachers - September 1959 to September 1960", Manuscript, October 1960.

PHELPS, FLORA L.
"A Summer of Science, Latin American Teachers Study with U. S. Colleagues at N.S.F. Institutes", Americas, 16-21, November 1960.

POWERS, WILLIAM H.
"Final Report on the Science Institute for Teachers Sponsored by The National Science Foundation at The Pennsylvania State University during the Academic Year September 1959-June 1960", Manuscript (c. 1961).

REYNOLDS, THOMAS D.
"Opportunities and Responsibilities in Science Education", American Journal of Physics, Vol. 26, No. 5, 330-333, May 1958.

ROBINSON, HOWARD A.
"Nuclear Education in the High School", Manuscript, January 1960.

SARNER, DAVID S. and EDMUND, NEAL R.
"Do Science Institutes Satisfy Teacher Objectives?", Science Education, 47, 31-33 (1963).

SCHENBERG, SAMUEL
"An Evaluation of the 1958 Summer Institutes Attended by Science and Mathematics Teachers from the New York City High Schools", Science Education, 43, 114-121 (1959).

SCHIPPERS, JOHN V.
"N.S.F. In-Service Institute in Astronomy and Space Science for Elementary School Teachers - Summary of Evaluation Forms Returned by Participants", Manuscript, February 1965.

SCHORR, D. P., REYNOLDS, T. D. and GERGEN, J. J.
"The Experimental Program for Retraining Retired Officers of the Armed Forces July 1958 to July 1964", Manuscript (1964).

SCIENCE SERVICE
"Forty Science Talent Search Winners Participating in a Discussion with Dr. F. Indorf, a Rough Draft of Notes", Manuscript, February 1959.

SMART, JAMES R.
"Follow-up Evaluation - May 1961 - for NSF Summer 1960 Institute for Teachers and Supervisors of Arithmetic - San Jose State College", Manuscript (c. 1961).

SMITH, ELMER R.
"Report on the Third Summer Institute for High School Teachers of Science and Mathematics, June 27 - August 5, 1960", Manuscript, October 20, 1960.

SMITH, ELMER R.
"Report of the Director, 1959-60 Academic Year Institute, Brown University, Providence, R. I. ", Manuscript, October 18, 1960.

SOUTHERN, J. A.
"Science in South Carolina High Schools", Manuscript (c. 1960).

WALKER, MARCIA
"Evaluation of Allegheny College National Science Foundation Summer Institute Program for High School Teachers of Science for the Years 1957, 1958 and 1959", Dissertation Manuscript, July 18, 1960.

WATSON, FLETCHER G.
"Final Report on Summer Institutes for High School Teachers on the Biological Uses of Radio-active Isotopes, Harvard University 1956, 1957, 1958 with Follow-up Activities", Manuscript, October 12, 1960.

WELCH, WAYNE W. and WALBERG, HERBERT J.
"An Evaluation of Summer Institute Programs for Physics Teachers", Harvard Project Physics (1967) Draft.

WHITAKER, MACK L.
"A Study of Participants in Summer Mathematics Institutes Sponsored by the National Science Foundation", Dissertation Manuscript, August 1961.

WILLIAMS, CLARENCE M.
"An Addition to the Administrator's Report of 1959 Summer Science Institute for Elementary School Teachers Offered at the University of Rochester", Manuscri[illegible] Date Unknown.

WILSON, HOWARD LEROY
"A Follow-up on the Participants of the Mathematics Academic Year Institutes Held at the University of Illinois from 1957 to 1962", Dissertation Manuscript, November 1966.

YON, JOHN
"Evaluation Report No. 11 of the Academic Year Institute for High School Teachers of Science Sponsored by the National Science Foundation at the Pennsylvania State University, September 1958 - June 1959", Manuscript (c. 1960).

YOUNG, GAIL S.
Comment on the work of the Institutes -- from letter dated September 28, 1959 to Dr. C. R. Phelps.

ZANT, JAMES H.
"An Evaluation of the Academic Year Institute for High School Science and Mathematics Teachers Sponsored by the National Science Foundation at the Oklahoma State University, September 1, 1957 - May 31, 1958", Manuscript, August 15, 1958.

ZANT, JAMES H.
"An Evaluation of the Academic Year Institute for High School Science and Mathematics Teachers Sponsored by the National Science Foundation at The Oklahoma State University, September 1, 1956 - May 31, 1957", Manuscript, October 1957.

EVALUATION OF THE COUNTRYWIDE ACADEMIC YEAR INSTITUTES PROGRAM

Summary of the Special Reports from Veteran Directors

by Paul A. Carnell

(Presented at the Meeting of Academic Year Institute Directors, Statler-Hilton Hotel, Washington, D. C., November 13 - 14, 1964).

The data reported was submitted by 30 institutions with Academic Year Institute experience which ranged from two to nine years.

The first three questions were:

1. What percentage of teachers who were in AYI programs remained in secondary school teaching?
2. What percentage of the AYI participants migrated into college teaching?
3. What percentage of the AYI participants left teaching for other types of employment? (A new responsibility not associated with a school, college or university).

A summary of these three questions for all AYI participants included in this report shows:

80% remained in secondary school teaching
11% migrated to college teaching
3% accepted other types of employment
6% accepted other school assignments, entered graduate school, undecided about future commitment, or unaccounted for because of lack of data

4. What changes has AYI participation produced in school programs?

One-third of institutions (10 of the 30) did not respond to this question.

Of the others (who offered a response), 4 reported that 50 to 60% of the science and mathematics courses had been upgraded.

Other comments made by Directors in relation to changes in school programs indicated that AYI experience had enlarged the sphere of influence of the participants in their institutions. This has resulted in the introduction into the school curriculum of new science and mathematics courses, including advanced classes, and the renovation of old courses.

Effective upgrading by AYI participants is also occurring through consultant activities and In-Service courses for teachers.

One Director reported that some participants have been instrumental in advancing the level of science and mathematics throughout the entire school system by means of in-service training programs for other faculty members and supervisory activities.

On the negative side (of question 4) some participants expressed considerable disappointment in not being able to enlist the support of administrators and fellow faculty members in the adoption of new curricula and modern points of view toward the teaching of science and mathematics.

5. Changes in remuneration as the result of AYI participation

The twenty-six Directors who submitted answers to this question reported that the percent of AYI participants who received salary increases ranged from 5 to 78%.

Specific salary increases reported by 13 Directors ranged from $100 to $6,800 per year with an average yearly increase of $800 to $1,000 for several years, as a direct result of AYI experience.

One Director said that none of his AYI participants had ever suffered in terms of salary. However, another indicated that 5% of his participants were penalized for losing a year of teaching experience.

6. Changes in professional status as the result of AYI participation

An analysis of the answers to this question revealed that the word "status" is not easily defined.

One Director said "The Institute participants feel that their status has been improved -- perhaps that is all there is to status".

Another said "If one considers college teaching as having "professional status" higher than secondary school, the AYI program has effectively increased professional status".

Other comments that were given in relation to professional status included the following:

1. Participants have more stature in the school and the community -- their advice and assistance is more eagerly sought.
2. Participants have a new interest in science education. They show an increased desire to join and become active in professional organizations.
3. They are in demand as consultants for curriculum planning and study groups.

One Director summed up these status ideas rather concisely when he wrote "The participants are now considered to be science teachers rather than just teachers".

7. Changes in the nature of responsibilities as the result of AYI participation

All of the 30 institutions reported an increase in responsibilities for a high percentage of the AYI participants when they returned to their teaching duties. The variety of these new responsibilities can be summarized by the following:

1. Appointment as Chairman of Science or Mathematics Department.
2. Assignments to teach advanced and special experimental classes.
3. Chairman of curriculum committees for developing new science and mathematics programs.
4. Teaching in-service courses to teachers in their school systems.
5. Appointments to supervisory and coordinator positions.

One Director reported that the most striking change for some of his participants was from the multiple responsibilities of teaching biology, chemistry, physics, and also coaching, to the single responsibility of one science discipline.

8. Changes in percentage of students studying science in their schools as a result of AYI participation

Only 8 of the 30 institutes selected for this summary offered any response to this question. The range of comments can be illustrated by the statements of two Directors. One said "There has been a marked increase in the percentage of students studying science over the past few years" and another indicated that "Very few teachers mentioned an increase in the number of students taking science".

One Director felt that the "quality of instruction was more important than numbers" and another said "It may well be that as a result of AYI experience teachers approach a course at a higher level and thus may discourage some students from studying science..........."

One institution supplied rather complete and specific data from 110 AYI participants. Nine of the 110 reported little or no change in the percent of students studying science.

However, 101 of the 110 participants (or 92%) reported increases in the % of students studying science ranging from 5 to 100. It was interesting to note that of this group of 101 participants over one-third (37%) reported a 100% increase in the number of students studying science. Two participants provided data which showed that the percentage increase in science students decreased as the grade level increased. For example,

in one case

100% increase thru grade 10
30% increase thru grade 11
15% increase thru grade 12

in the other case

9th grade 100% increase
10th grade 60% increase
11th grade 40% increase
12th grade 20% increase

9. What would happen if the AYI program were to be discontinued?

The responses of the 27 Directors who answered this question can be summarized as follows:

Very few colleges and universities would keep this program going and there would be a definite slide to a lower level of competence in high school science and mathematics instruction. Many science and mathematics students would return to education courses for graduate credits. The psychological impact of the discontinuance of the AYI program would produce a serious lowering of morale among secondary school science teachers. There would be an increased demand for summer and in-service institute experience, but many Directors stated that these programs could not provide many of the values of Academic Year Institutes.

The concerns that have just been discussed were effectively reinforced by the statement of one Director who expressed his thinking as follows:

"I suppose the world would keep turning if the AYI program were to be discontinued, but some would have their doubts. There would be serious repercussions all the way back to the pre-service teacher education programs. Fewer good students would elect to teach since many of them are influenced by the prospect of institute support after they enter the profession. Others would leave teaching at the first opportunity and more of them would resort to bus driving, coaching and administrative jobs in order to better their financial circumstance".

10. Has the AYI program exhausted its market?

One-hundred percent of the 30 Directors responded with a "No" to this question. However, the meaning of the work "market" may be changing.

Nine Directors felt that perhaps the top teachers had already attended AYIs and that the quality of applicants had noticeably deteriorated in the last 4 or 5 years. Several Directors indicated that there was an abundance of potential applicants at the sub-optimal level and one Director described this group as consisting of

1. Older teachers with little or no mathematics or science background.
2. Secondary school mathematics and science teachers with poor college grades.
3. Supervisors in mathematics and science at the local and state level.

Questions 11 and 12 have been combined for this summary. Should the AYI program be continued at a reduced or increased level?

Twenty-seven Directors responded to these questions. Eleven percent favored a program of reduced magnitude; 37% preferred the current level of operation and 52% recommended that the program be expanded.

Of the three Directors who favored a reduced level of operation, one said that this would make the program more attractive to those who qualified. The other two Directors in the "reduced level" group proposed operating an AYI program designed more specifically for the backgrounds of the participants. For example, three levels of institutes would be offered for teachers with poor, average and superior backgrounds.

For those Directors who favored an expanded program, one mentioned that he still had a ratio of 30 to 1 applicants to stipends. The others who favored expansion were interested in particular participant markets, such as poorly prepared secondary teachers, junior high and general science teachers, college teachers, supervisory, and key elementary science and mathematics personnel and participants who would become active in in-service work upon return to their institutions.

One Director felt that the purposes served by many of the small institutes could be served as well or better by a fellowship program. He also stated that on-going institutes should be allocated an optimum number of participants for efficient operation - "there is nothing magic in the numbers 35, 40 or 45".

13. Are there practical alternatives to government support for stipends -- such as sabbatical pay or private fellowships?

Twenty-six of the 28 respondents to this question felt that there were no practical alternatives to government stipends for secondary school teachers. However, one Director suggested that increased salaries for teachers would solve the problem and another proposed that teachers be hired on a 12-month basis and attend summer institutes at the local level.

Sabbatical leaves apparently are not yet available to the majority of AYI participants. One Director reported that about 5 out of 35 of his participants had received sabbatical consideration. Another said that 37% of his participants indicated that they could get sabbatical pay after 6 or 7 years of service.

The disadvantages of an AYI program supported by sabbatical pay and/or private fellowships were enumerated by several Directors:

1. The process of sabbatical leave would introduce a pre-selection mechanism.

2. The uncertainty of sabbatical pay and fellowships would produce the following problems:

    a. It would be difficult to have enough time to plan a well-integrated program organized for a specific number of participants.

    b. It would be difficult to select individuals to fit a particular program.

    c. Group values of the current AYI program would be lost when a participant was not 1 in 30 but perhaps 1 in 1500.

14. To what extent can, or would the type of course programs offered to AYI participants continue to be available during the academic year on a regular "catalog" basis supported by tuition, but without guarantee on numbers of registrants?

Sixteen of the 26 Directors who responded to this question indicated that, at their institutions, the AYI courses would either be dropped immediately or phased out gradually because of anticipated low enrollments.

Seven Directors said that some courses might be offered but because of probable low enrollments they would expect increased difficulties with staff recruitment and laboratory and classroom space requirements (primarily because only the least desirable areas would be made available). These problems might make it impossible to maintain a well-balanced, diversified program.

Three institutions indicated that the current AYI courses would probably be shifted from the academic year to the summer session.

15. What experimental patterns should continue to be explored in the AYI program?

Of the 26 Directors who responded to this question, 15 favored a continuation of the current pre-service and supervisory training programs.

Two Directors felt that the pre-service program should be eliminated because (1) the participants do not yet know their needs, their problems or their weaknesses and (2) the responsibility for pre-service training should be assumed by the public schools.

In another response, a Director suggested substituting for the current pre-service program a new program that would take college sophomores or juniors through a planned sequence for their next two or three years in college so that when they received the bachelor's degree they would be reasonably well-qualified. "Why wait" (he asked) until they have had four years of college and then try to remedy the situation"?

Three Directors suggested a need for more study to develop the special science and mathematics courses required for AYI participants.

Another Director said "In the long run, I would like a pattern of regular academic study every 6 or 7 years for even the best trained teachers".

Additional programs of interest to several directors included those with an emphasis on the training of junior high school science teachers, junior college and college teachers.

16. What new experimental patterns might be considered in the AYI program?

The following suggestions were made:

1. More attention to poorly trained teachers, elementary teachers, junior high, junior college and small college teachers.
2. Offer a partial In-Service - partial Academic Year program that would run for example, from Thursday night through Saturday noon. (A five-hour course could be offered each semester. Master's degree could be obtained in two academic years plus two summers).
3. More AYI Institutes to train in-service Directors for local school systems, particularly at the elementary level.
4. A program in which college teachers are trained to prepare secondary school teachers of science and mathematics.
5. A fifth-year, non-degree program for teachers who are not admissable to graduate school because of poor academic records (to be conducted by colleges without graduate programs).
6. Select 50 outstanding high school seniors who want to become, for example, physics teachers. Offer them a 4-year program conducted like AYI with special sections and perhaps special courses. (Participants would take regular university courses for work outside of the sciences and mathematics).
7. Additional academic year institutes to train top AYI participants to become college teachers or a high level 3-year program in which teachers would participate in regular Ph.D. program.

8. Direct grants to institutions. The institution would then select individuals as fellows or scholars and would also establish and maintain appropriate work-shops, conferences, in-service courses, research in teaching methods, etc.

9. Train special mathematics teachers to teach only mathematics in the 4th, 5th and 6th grades.

10. A cooperative project between colleges and high schools in which the total discipline, for example mathematics, would be completely modernized. This would include in-service training of all mathematics teachers, curriculum advice, and demonstration of good techniques for teaching new ideas in mathematics.

MEASURES OF IMPACT

Final Chapter of "An Investment in Knowledge - A Study
of the National Science Foundation's Summer Institutes Programs"
by Hillier Krieghbaum and Hugh Rawson, Prepared Under a Contract
With New York University, 1965

Attempting to evaluate the Summer Institutes program of the National Science Foundation is a little like the elementary science experiment in which iron filings are tossed on a paper beneath which is a magnet -- each speck of metal, by itself, has little meaning but together they make a distinct pattern.

Many independent observers have felt the pattern of Summer Institutes has been beneficial for the Nation.

Dr. James B. Conant, in his 1963 book, "The Education of American Teachers," emphasized the need for continuing in-service training for teachers and cited the work of NSF. Conant said in a sentence that was italicized:

> "The use of /NSF/ summer institutes for bringing teachers up to date in a subject-matter field has been perhaps the single most important improvement in recent years in the training of secondary school teachers."

Conant liked the NSF efforts so much that he recommended that local school districts collaborate with educational institutions in their areas to provide such training for even larger numbers of teachers.

Samuel Schenberg, director of science for New York City's public schools, told a 1962 meeting of the Association for the Education of Teachers in Science:

> "The National Science Foundation, through its sponsorship of summer institutes and revisions of existing courses of study on a nationwide basis, is making a highly significant contribution to the improvement of science and mathematics teaching in the junior and senior high schools of our country. The impact of these programs is already influencing the offerings of our colleges in the freshman year. In a brief period of a half dozen years the NSF by virtue of the tremendous financial resources at its disposal has demonstrated that a national agency can raise educational standards in every city and hamlet in the United States without infringing upon the rights and control of local school systems."

Dr. Francis Keppel, U. S. Commissioner of Education and a member of the SPE Divisional Committee since the time he was Dean of the Graduate School of Education at Harvard University, stated in 1965:

> "Classroom teachers, as we all know, face tests as well as give them. Perhaps the greatest test is that of adapting to the bewildering pace of change.
>
> "Teachers must provide instruction geared to educational needs that break sharply with tradition. They must respond to a new sense of social and economic values. They must keep abreast of constant expansion of the store of knowledge that is to be transmitted in the classroom. Changes of these kinds have particularly challenged teachers of science and mathematics -- subject areas that have been most pervasively revolutionized in recent times.
>
> "The challenges are being met, and the institutes programs administered by the National Science Foundation have made a major contribution to our success. Through these institutes, teachers have become familiar with recent advances in their special fields of knowledge. They have familiarized themselves with new courses of study. They have developed new approaches to learning and teaching -- benefiting not only themselves and their students but inspiring their fellow teachers as well.
>
> "Beyond these accomplishments, the NSF institutes program has demonstrated that Federal efforts can produce substantial educational improvement. Its success has led to the development of similar institutes in other subject fields and it has taught the important lesson that the quality of education in the classroom is amenable to swift improvement by concentrating on the competence of the classroom's centrally important figure -- the teacher."

The Rev. C. Albert Koob, O. Praem., associate secretary of the National Catholic Educational Association's Secondary School Department, made this statement in early 1965:

> "The NSF summer institutes for teachers of mathematics and science have had a very positive influence on the quality of teaching in the Roman Catholic secondary schools. When one assesses the value of these institutes it becomes evident that their contribution was much more than that made to a group of individuals, for they tended to create an atmosphere that looked for up-grading and improvement throughout the entire system. The first real evidence of their influence came in 1961 when the curriculum advisory committees were set up by the NCEA. When members were sought for the mathematics and science committees, it was

> obvious that the leaders who came forth were either the products of these institutes or teachers looking forward to attending them. Our regional institutes and our national convention have abounded with papers recommending improved science and mathematics programs, and always, the recommendation was made that NSF institutes would be a must."

In its Educational Supplement for September 15, 1961, "The Times" of London reported:

> "Largely as a result of N.S.F. initiative, it is now accepted in America that universities must keep school-teachers up to date in an evolving subject by providing instruction for them on a substantial regular scale, and that such work will in future be a significant fraction of a university's functions."

Dr. John R. Mayor, director of education, American Association for the Advancement of Science, wrote in an editorial in the association's publication, "Science," May 25, 1956:

> "The summer institute program of the National Science Foundation, now extended at Wisconsin and Oklahoma A and M to include year-long institutes, has made a major contribution in making available content courses for science and mathematics teachers. This is one of the most significant developments in teacher education in the past 20 years."

Dean B. Roger Ray of the Division of Sciences, Washington State University, Pullman, Washington, made this comment in July, 1964:

> "The Institute Program has been more responsible than any other factor in achieving a substantial up-grading of competence of science and mathematics teachers in secondary schools. I believe it has been the primary factor. We continually see the results in general and specific ways. Each freshman class in the University is better prepared in science and mathematics than the previous one, for instance, as shown by our Mathematics Placement Test scores. These students are getting instruction in their basic high school courses that is more substantial and modern. We have an increasing number of freshmen who obtain advanced placement, in good part because additional science beyond the minimal requirement is being offered in the high schools by competent teachers. Frequently we can correlate the quality of the work given in a high school with a specific teacher who has participated in the Institute Program."

Beyond these general statements, however, it is difficult to ascertain and measure the impact of the NSF Summer Institutes.

It appears obvious, though, that a summer or more spent in the classrooms, laboratories, and on field trips should improve the competence of the secondary school science and mathematics teachers who have attended Summer Institutes.

But how can one be sure?

Certainly one might assume that something -- hopefully something good -- came as a result of the money that has been spent on institutes since 1953. Determining exactly what that something was, unfortunately, has remained a difficult problem. Over the years, NSF has accumulated statistics about the impact of the institutes.

Pre-Sputnik attempts to evaluate the effectiveness of the institutes addressed themselves to such points as the "before and after" questionnaires given to participants who attended 1955 Summer Institutes and follow-up surveys made of sample groups of 1955 and 1956 participants a year after their institute attendance. The second of these follow-up studies resulted in figures such as these: 40 percent of the teachers interviewed felt their competence had improved as a result of attending an institute; 19 percent said they had more enthusiasm for their work as a result; 8 percent said they had revised their courses on the basis of what they had learned at the institute.

Of post-Sputnik evaluation studies, the most detailed was one conducted in the fall of 1959 by the Bureau of Social Science Research, Washington, D. C. This study was centered on a group of 538 teachers from 503 high schools who attended Summer Institutes in 1957. In 251 of the schools, interviews also were conducted with principals or supervisors and with teacher colleagues of the 1957 institute participants.

Approximately five out of six principals said they would consult a former participant rather than another teacher when they wanted advice on new teaching techniques; three out of four said a person who had attended an institute would be given preference in assignment to a new subject. Principals also expressed strong preference for institute-trained teachers for assistance in selecting new equipment and textbooks, acting as advisors to science clubs, and serving as a representative at teachers' conferences.

Major reason for these preferences was that institute alumni were considered more enthusiastic and interested in their jobs. But undoubtedly this was a trait that they had before going to an institute. According to 82 percent of the principals, teachers who applied for institutes were more enthusiastic than those who did not.

Participants themselves summed up the institutes' effects in the following manner: Eighty-three percent said they learned new subject matter; 39 percent said they learned new techniques of teaching their subject; 35 percent gave the institute credit for their assignment to teach more advanced sections; 28 percent said the institute was a source of added enthusiasm or improved self-confidence; 21 percent said they had profited from the program by widening their social contacts.

On their return to their classrooms, many participants said they made changes directly as a result of their institute experience. Forty-eight percent said they introduced more advanced subject matter into their courses or broadened their coverage; 29 percent said they brought newer subject matter into their courses; 29 percent said they also put more stress on student participation through such devices as encouraging special projects; 17 percent said they devoted more time to laboratory work; and 15 percent said they made greater use of audio-visual aids.

One key finding in this study was that institute attendance had a definite cumulative effect. Of the teachers who attended only one institute, 32 percent reported "a great deal" of improvement in their course work. The same response was given by 41 percent of the teachers who had participated in two institutes and by 59 percent of attendees at three institutes.

Another section of the study compared attendees with those who had never been to institutes. While 34 percent of those attending an institute reported that they had been assigned a new course within the previous two years, only 24 percent of the nonattenders could say the same thing. Institute attendees were more inclined to modify their teaching of courses than others.

Although it did not show up in studies such as this, more informal surveys suggest that teachers who have been to institutes sometimes become victims of their own enthusiasm. Upon returning to their schools, they may find that administrators and other teachers are not ready to accept the new ideas they have learned. Teachers who have been in this position say it can be quite a psychological blow to have been exposed to one of the revised science or mathematics programs and then have to continue teaching what they have come to regard as an inferior course.

No one is sure just where the breakpoint is, and it undoubtedly varies according to school size, but there is a widespread feeling among those connected with the institutes programs that if only one teacher in a school has been to an institute, he may well be ignored; if there are two, they will be listened to; and if there are three or four, things will start happening in that school.

From the school administrator's point of view, the institute-trained teachers can be something of a problem. Father Koob, for example, after pointing out that the one obvious drawback of the institutes was that there were not enough of them to meet the demand, continued:

> "At the high school level the teachers sometimes tended to be a bit too vigorous upon their return. They urged the schools to put in college material, add laboratory equipment, select the better students, augment the programs, and in general make the schools revolve around the new math and science programs. There was a resulting lack of balance for a time which definitely was not appreciated by the people in other fields -- English and social studies in particular. This situation probably had to exist, however, as the schools were confronted with the rise of technology and the ever increasing emphasis on scientific knowledge."

Another NSF-financed study was made by the American Institute for Research to ascertain characteristics of teachers who never applied to attend an institute. This study, conducted during the 1961-62 school year, delineated the group of high school teachers not being reached by the institutes programs. (They can never attend if they do not apply.)

The most significant single finding was that more than half of the science and mathematics teachers in the Nation's high schools had not submitted an application to any institute during the previous five years.

The report also found that "a person fixes on the type of Institute which best meets his needs and does not tend to apply for other types of Institutes. In other words, we are not dealing with an 'application syndrome.'"

The profile of a typical nonapplicant looked like this (as compared with applicants):

> "The Non-applicant is more likely to be a woman, teaching in a small (grades 7-12 or K-12) school, located in a rural or small town area, and serving a comparatively low cost housing area. No relationship was observed between application and such common variables as percentage of parents belonging to PTA, father's income, etc. However, there is likely to be a public library available to the school, and there is some tendency for the parents in the community to be of the professional, clerical, rather than the farming class. The teacher is likely to be married (but no more likely than Applicant teachers), and is no more likely to have dependents than are Applicant teachers. The Non-applicant teacher is likely to regard the environment surrounding him as being

> comparatively less favorably inclined toward education and Science in particular, both on the part of the parents and the community in general and on the part of his colleagues and the student body."

Why did these teachers not apply? Generally, nonapplicants cited other obligations as the main reason for not applying to an institute. These included family obligations (mentioned most frequently by women) and financial obligations, such as having another year-round job, having a permanent summer job, and being able to make more money elsewhere (mentioned most often by men).

Discussing the psychology and motivations of the typical nonapplicant, the study stressed that nonapplicants tended "to come from a small school in a small town, and that such an environment is likely to be characterized by a narrow conservatism, 'a small town attitude,' in which Science and education are seen in the traditional conservative light."

The report said nonapplicants were probably right when they said the attitude in their communities was relatively unsympathetic to science and education and pointed out that the schools in which nonapplicants taught tended to offer somewhat less extensive course groupings in science and mathematics, to pay somewhat lower salaries, and to be made up of students of somewhat less ability.

The report recommended that NSF consider "stratifying" the institutes programs by ability level or in terms of background of the teacher. (This NSF has tried to do in recent years.) For example, it suggested that programs designed especially for small-town teachers might be particularly effective. It stated:

> "It should be remembered that just the fact of applying represents to some extent staking the emotional well-being of the teacher on being accepted particularly for the teacher with the type of personality that we are talking about (likes to be admired, respected and finds main satisfactions with people rather than subject matter). This would be particularly true of teachers coming from small towns or small schools where they are known by the rest of the faculty, the town, and the student body. In such situations the fact that a teacher has applied and been rejected quickly becomes known and constitutes a source of embarrassment and disgrace to the teacher regardless of what the objective reasons for rejection have been. Many of the teachers in the Non-applicant group are likely to perceive the situation this way, whether or not it is this way in truth."

Low-level programs, it was pointed out, would be less threatening to the ill-prepared teacher especially if, taking into account the orientation of nonapplicants to students rather than subject matter, appeals to the teachers were "slanted toward what can be done, not for him, but for the students on which his focus rests."

One implication of this study's profile of the typical nonapplicant is that an increase in the size of stipends would not bring a dramatic rise in the number of teachers applying to the institutes programs. More informal soundings of teacher opinion point to the same conclusion. This would seem to mean that short of the Orwellian solution of putting teachers in intellectual concentration camps during summers, NSF already is within effective range of its peak drawing power as far as secondary school teachers are concerned. Many of the teachers who have not yet applied to institutes probably are never going to apply, at least as the program now is structured.

Another implication of this study is that the NSF institutes are having a greater impact on urban than on rural high schools. This conclusion also was supported by an independent study of the effects of national educational programs (including NSF) on secondary schools in Illinois by Roald F. Campbell, of the University of Chicago, and Robert A. Bunnell, of the Ford Foundation. In an article in the Winter, 1963, issue of "The School Review," they said that "schools in rural areas and serving populations of low socioeconomic status have not benefitted as much as the more favored schools with a result of widening the gap that may already have existed between them." In other words, the good tend to become superior and the poor continue in mediocrity.

Other key aspects of the institutes programs are revealed by a series of analyses made each year since 1961 of information obtained from institute application records. The most recent of these, covering institutes held during the summer of 1963 and the 1963-64 school year, contains such data as the following:

(1) Sequential participation. Indicating the number of teachers working on long-term, coordinated study programs, the data showed that 16 percent of the secondary school teachers who attended Summer Institutes in 1963 also had participated in either a Summer or an In-service Institute at the same college or university during 1962-63. Approximately 5.5 percent of the 1963 group had attended Summer or In-service Institutes at the same institutions in both 1961-62 and 1962-63.

(2) Repeaters. In 1963, 45 percent of the high school teachers who attended Summer Institutes had never before participated in an institute of any type. For the institutes programs as a whole, 53 percent of the 42,939 participants in 1963-64 had been to institutes previously. Of those who had attended more than once, 60.1 percent had been to one previous program; 25.6 percent to two; 11 percent to three; 2.9 percent to four; and 0.4 percent to five.

(3) Local orientation. The bias of many institutes toward serving teachers from nearby areas was shown by analyzing institute rosters by State and census divisions. Again taking institutes of all types (including In-service Institutes which are by definition locally oriented), 62.3 percent of the participants surveyed in 1963-64 went to institutes located in the same State in which they were employed. Approximately three-fourths of the participants stayed within the same census division when they went to an institute.

Because of the large number of teachers who have attended more than one Summer Institute, NSF does not know exactly how many individuals have received institute training. All it knows is the total number of training opportunities that it has provided -- about 150,000 for high school teachers in Summer Institutes from 1954 through 1965. Best estimate of the NSF staff is that these 150,000 training opportunities have been used by approximately 90,000 individuals or about 40 percent of the 226,000 science and mathematics teachers in the Nation's secondary schools during 1964-65. Because of losses of individuals who drop out of secondary school teaching after receiving NSF training, the actual percentage of the current teaching force with Summer Institute experience is somewhat lower -- probably about 35 percent. These estimates appear in line with a nationwide study conducted for NSF during the 1960-61 school year by the National Association of State Directors of Teacher Education and the AAAS which found that 20 percent of the sample had completed at least one Summer Institute up to that time.

An attempt to describe the overall impact of the institutes was contained in an NSF staff paper written by Dr. C. Russell Phelps, shortly before he became head of the Institutes Section in the summer of 1963. His description of the effects of the institutes for secondary school teachers was only part of a much longer text. In only a few instances did he buttress his judgments with specific facts. His general statement, however, revealed what NSF believed it had done.

Phelps considered first the effects of institutes on high school students:

> "The most obvious effect, and the best measure of the programs dedicated to the subject matter improvement of high school teachers, has been the marked improvement in the caliber of college freshmen. Many universities have noted the sharp rise in the mathematical backgrounds of their entering students, and especially in the improved understanding of a mathematical and logical approach to the solution of real problems. Because the high school student ordinarily studies only one year of a given science, as compared with three or four years of mathematics, the effect of teacher improvement on the resulting knowledge of science on the part of the graduating high school student is not always as noticeable as

in mathematics; however, there are a number of colleges which now permit some students to bypass the beginning college course because of their superior backgrounds."

In attempting to assess the institutes' effects on students, one complicating factor is the dynamics of the program itself. Its goals today are not the same as when it began. Much of the early support for the program arose from fear the USSR was surpassing the United States in the production of scientists and engineers. The theory, repeated over and over during the early years, was that assisting and inspiring high school teachers in institutes would result in more of their students going into scientific careers. This idea, in turn, grew out of the observation when NSF began to support training programs for college teachers in the early 1950's that a number of "master teachers" in the small colleges of the Nation were sending far more than their proportionate share of students to graduate work in science and mathematics. Whether such a program as the NSF institutes actually influences more students to go into careers in science and mathematics is open to question.

A study published by NSF in early 1964, for example, showed that since 1901 the increase in numbers of students earning bachelor's degrees in science (including mathematics) was in almost precise proportion to the increase in population. Moreover, during this period the traditional sciences, including biological sciences, chemistry, and the combined group of mathematics, physics, and other physical sciences, declined as a percentage of all science degrees, while compensatory increases occurred in psychology and the social sciences. Illustrating the shortrun situation, figures for 1951 through 1962 showed that science baccalaureates as a percentage of all baccalaureates rose from 23.95 percent to 25.38 percent. During these years, the biological sciences, chemistry, and the physical sciences decreased on a percentage basis, while mathematics, physics, psychology, and the social sciences gained relatively. Mathematics, which jumped from 1.60 percent to 3.58 percent of all bachelor's degrees, showed the largest increase of any science during the 1951-62 period, both in terms of percentage growth and actual numbers of degrees.

NSF's Office of Science Resources Planning does not envision any major increase in the percentage of students earning science degrees during the rest of this century. Bachelor's degrees in all sciences are expected to rise to only 26.59 percent of all degrees by the year 2000, up only 1.21 percent from the 1962 figure.

One important factor that both the studies of degrees awarded and the projections fail to take into account is: Students who received baccalaureate degrees up to 1962 could have been affected only by teachers who attended institutes prior to 1958, and these represent only a small fraction of the total number of institute participants.

Some evidence exists that interest and enthusiasm of the best students for science and mathematics may be declining. A 1964 study of the career decisions of semifinalists in the National Merit Scholarship Program showed humanities and social sciences gaining at the expense of the physical sciences and engineering. Commenting on the study, Dr. Robert C. Nichols, National Merit Scholarship program director, wrote in the June 12, 1964, issue of "Science," weekly publication of the American Association for the Advancement of Science:

> "During recent years there has been an unprecedented national campaign to interest talented students in scientific and technical careers. Bright students have been urged to choose careers in science in the interest of national security and national prestige, and they have been lured by multi-billion-dollar science budgets, the adventure of space exploration, and plentiful fellowship support. Yet talented students have shown an ever increasing interest in fields which are singularly lacking in these advantages.
>
> "It is hard to believe that the recruitment programs and the increasingly favorable public image of science and technology have actually discouraged the most able students from entering these fields, yet alternative explanations are not plentiful . . . One must conclude from these observations that the factors determining the distribution of talent are not simple, and that many important influences remain unknown."

In his staff analysis, Phelps made the additional point that institute participation had helped keep teachers in the schools. He cited several factors contributing to this result: (1) credits that teachers were able to earn in their subject fields by attending institutes, thus removing deficiencies in their certification requirements; (2) salary boosts which they receive because of their advanced training; and (3) income that teachers receive in stipends, which enabled them to support their families during summer months and to resist the lure of throughout-the-year incomes of other occupations.

While the program has helped teachers stay in secondary schools, Phelps pointed out that several hundred teachers annually transfer from the high school to jobs in junior colleges and universities. Such moves have been particularly prevalent among teachers who have attended Academic Year Institutes and extended sequential programs. In this respect, in-service work served as pre-service training.

While losses to college teaching disturb some secondary school administrators, NSF officials regard the upward mobility of high school teachers as a generally beneficial side-effect of the programs. Their only qualms occur when they hear of instances in which a college or junior college has hired a high school teacher on the basis of his institute training even though he was not really prepared for teaching at the higher level.

Dr. Bowen C. Dees, NSF associate director for planning and for many years head of the SPE Division, took the position that there "should be a lot more dialogue between the high school and college levels."

He said the Nation "ought to have a system in which good people in secondary schools can move up if they want to." Such moves, he continued, can increase the morale and raise the status of high school teachers generally, as well as help make high school and college teaching "one profession."

Another important effect of institute activities, according to Phelps, "has been the renewed interest of college and university faculties in the problems of the secondary schools, and especially in the problems relating to subject matter study by teachers."

A realization has developed, he said, that graduate and undergraduate science and mathematics courses, traditionally designed to lead the student into research, are not necessarily -- in fact, not usually -- the best courses for giving teachers a broad grasp and sound understanding of fundamental concepts in a subject area. As evidence, Phelps cited the program for training secondary teachers in mathematics that was recommended in 1960 by the Committee on the Undergraduate Program in Mathematics.

The CUPM program is far different from the usual pattern expected for admission to graduate school, Phelps said, adding that differences are not in quality but in a judicious selection of courses and content oriented toward undergraduate training of teachers, including several courses normally given previously only at the graduate level.

Practically everyone agrees that the undergraduate curriculum for training teachers has changed since Sputnik and that the changes have been in the direction mentioned by Phelps. Again, however, the exact extent to which NSF institutes have been responsible is impossible to measure.

Certainly many of the people who have been involved in such efforts as the CUPM report also have been active in institutes. And it is not uncommon for visitors to institutes to learn that the special courses developed for teachers in the summer have served as models, or occasionally been adopted virtually intact, for new courses offered to undergraduates during the regular school year. But whatever the actual influence of institutes in this respect, the degree of change in the undergraduate curriculum for training teachers has been less than NSF originally hoped for -- and the changes have taken longer than expected. For example, a 1960 staff study of the Academic Year Institutes stated:

> "It was anticipated that the step from working with experienced teachers to modification and improvement in quality of programs for undergraduates preparing to teach would be an easy and obvious one. However, it is now clear that the step is a difficult one for the universities to take . . . Even those scientists who have accepted the responsibility for retraining teachers via institutes, and who have done it very well, have not yet been able to be of material influence with the college of education in the undergraduate training of teachers."

Four years later the situation, as NSF viewed it, was much the same. A staff paper presented at a meeting of the SPE Divisional Committee on February 6-7, 1964, stated:

> "As a means of developing some degree of teacher competence the 'institute' technique of re-training in-service science teachers was adopted. This technique has helped to bridge the gap but has not been sufficiently effective in bringing about improvement of pre-service teacher training."

This strikes right at the heart of NSF's efforts to improve science education. Unless the new people who enter the profession each year are well-prepared in the subjects they are going to handle, the institutes programs will have to continue indefinitely the teaching of basic material that teachers never learned as undergraduates. As the 1964 staff paper said:

> "The country can no longer afford to continue producing teachers inadequately trained at the outset in the subject matter they will be teaching. Although it is necessary to continue to provide intellectual refreshment for in-service teachers -- both to avoid obsolescence in teaching and to ensure a source of well-trained leaders for the school systems -- the Foundation's experience and resources also can be utilized to improve the training of potential teachers."

In addition, an important question has been raised as to whether institutes, which originally were conceived primarily as a mechanism for updating teachers, are the most effective way of providing basic grounding in science and mathematics that teachers appear to need. Discussing a study by the Committee on Education of the National Association of Geology Teachers, the January, 1964, "Newsletter," published by the Earth Science Curriculum Project, stated:

> "Among seventy schools reporting on the NSF Summer Institutes, which incorporate earth science subject matter, not one respondent recommended them as the most effective method of teacher preparation. Although admittedly useful in 'bridging the gap,' even the most carefully planned summer institute cannot provide

> sufficient background material to produce well-prepared earth science teachers. Nevertheless, until such time as earth science teacher preparation programs become more widespread and better established, summer institutes will continue to be important introductory and refresher sessions for earth science teachers."

Facing up to this problem, NSF has considered a number of possible programs for pre-service teachers. But to date, the only thing tangible that has been done is to train a few pre-service teachers in regular Academic Year and Summer Institutes. The current NSF attitude was summarized by Dr. Henry W. Riecken, NSF associate director for education, at a meeting of the SPE Divisional Committee on June 4-5, 1964:

> "The staff has wrestled with the question: Should the Foundation be in the business of pre-teacher education, and if so in what way? We have come to the conclusion that unless there is good reason for staying out, we should be in it for improvements are needed."

Just when and how NSF will attempt to do this is not yet clear.

While there is evidence the lessons learned by the colleges and universities in holding institutes have had some effect on their undergraduate programs for pre-service teachers, NSF has been much less successful in its attempt to persuade these institutions that they are responsible for training teachers already in service. Many colleges and universities, of course, have shown their interest in this job by submitting proposals for, and receiving grants to, hold institutes. A substantial number have even gone so far as to create special degrees for teachers in their institutes.

Only a few colleges and universities are prepared to support programs of this type on their own, however, as NSF found out when it sought to phase out support for the Academic Year Institutes. A large majority of the institute directors said that without Federal funds the special programs for teachers at their schools would be discontinued. For example, a 1959 survey of directors of both Academic Year and Summer Institutes showed, by a margin of about three to one, that the directors believed Federal support to be essential. Talks with institute directors during the summer of 1964 indicated that opinion on this subject has not changed much since.

As for developing "mutual understanding between college and high school teachers of science and mathematics," which the Foundation set as one goal in the early years, many observers of the institutes programs feel this has been an important byproduct. Yet such opinions are not unanimously held. Conant, who with his staff visited 77 colleges and universities in 22 states to gather material for "The

Education of American Teachers," stated in that book:

> ". . . I have found institution after institution in which most, if not all, the members of a subject matter department (English or chemistry, for example) were totally unfamiliar with what was going on in the schools and couldn't care less."

More optimistically, Dr. Paul M. Gross, for many years a National Science Board member, said:

> "The institutes programs have demonstrated the effectiveness of cooperation between universities and high schools. Historically, the colleges and universities paid little attention to the high schools. Everyone complained about the poor education of incoming students, but all the great majority did about it was to complain.
>
> "The institutes have provided the machinery for bridging this gap. For the first time, college faculty members have had to rub elbows with the high school teachers. They have started to realize where the high school problems are and have begun to help with them."

In this sense, the institutes preceded slightly -- and worked hand-in-hand with -- the course improvement projects supported by NSF and other organizations which have brough professional scientists back into the business of writing textbooks for high school students after a half century hiatus.

Typical of the attitude of people associated with the Course Content Improvement projects is this statement from Dr. Jerrold R. Zacharias, Massachusetts Institute of Technology professor who has been a moving spirit in developing the Physical Science Study Committee:

> "The National Science Foundation-sponsored PSSC summer and in-service teacher training institutes have been an essential part of the overall PSSC physics program. They perhaps more than any other single influence have helped make the course immediately useful to teachers and students. Since the PSSC program is far more extensive and penetrating than the conventional course in physics, it is important for teachers to become familiar with the material and the interrelated use of the text, laboratory, and films before they teach the course for the first time. Here the institutes have made a major contribution, but they do more than prepare physics teachers to teach the PSSC program; they also strengthen the teachers' knowledge of physics and broaden their background of experience which help them become more effective physics teachers regardless of the program they use.

> "The majority of the 5,000 physics teachers who are now teaching the PSSC program have been to PSSC institutes. But not all of the teachers who go to a PSSC institute will teach the PSSC program, and this is as it should be. Comments from this group of teachers show that the institute is beneficial for them too . . .
>
> "Another point should not be overlooked. The PSSC physics course materials make it possible for directors of physics institutes to offer an outstanding program in physics. The PSSC text, lab and films are superior to the sophomore and junior year physics lecture courses that are too often given to teachers in regular physics institutes. The teachers find it difficult, if not impossible, to translate the material taken from a college level course into something that they can use in their high school classrooms. But the PSSC institute not only strengthens the teacher's background in physics but acquaints him with a set of learning aids that he can use in teaching physics to high school students."

Of curricular revisions in chemistry, Dr. George C. Pimentel, professor at the University of California at Berkeley and director of the CHEMS program, said Summer Institutes were "a natural and necessary appendage" of introducing the new program. He said:

> "I believe that chemistry teachers with strong background in content can teach CHEMS without too much retraining but the average teacher probably would be well advised not to undertake this change without retraining. This is where the Summer Institutes play their vital role."

Much the same attitude for mathematicians working on improvements in the high school curricula was revealed in the following comments of Dr. Max Beberman, who is in charge of the University of Illinois Committee on School Mathematics Work:

> "New curriculum materials for secondary school mathematics are now widely available. However, the mere availability of 'new' textbooks will not bring about widespread curriculum change. Many teachers are reluctant to undertake the teaching of such new courses without some training in the mathematical content and background of these courses and the ways in which these mathematical ideas may be presented to secondary school students. Thus, we see a need for institute courses which will enable teachers to learn more subject matter and to see the relevance of this new subject matter to the courses they teach in high school.
>
> "We have noticed that teachers who started with us with a scanty background in mathematics have, after a year or two

> of teaching experience with UICSM, developed a genuine interest in, and felt a need for, more formal training in mathematics; many have enrolled in summer and academic institutes where graduate courses have been available. Many of these teachers have told us that they could not have understood such courses prior to their experience with UICSM courses at the Illinois Summer Institute."

Beberman said he was dismayed by signs of a bandwagon effect where administrators were introducing new curricula without paying needed attention to teacher retraining and adequate supervision. He continued:

> "Although it is a fine thing to jump in and get one's feet wet, we predict that there will be so many unsuccessful attempts that all of the new programs may be set back by the protests of disappointed students, parents, and teachers. Strong measures are required to get things off to a good start and to keep them moving successfully. And this must continue until teachers and parents gain experience and confidence.
>
> "Without the NSF Summer Institutes, any widespread inauguration of new curriculum reforms would be most difficult -- if not impossible."

In measuring the twin results of institutes programs and course content revision projects, one has to realize that (1) tests administered annually by the College Entrance Examination Board show no discernible trends from year to year in the achievements of students in science and mathematics but (2) admission officers at many colleges and universities indicated that incoming freshmen during each of the past several years have been successively better and they attributed much of this improvement to the institutes programs and revamped high school curricula.

Discussing the second point, William M. Golden, executive assistant on the UICSM project, said:

> "I believe I am correct when I say that only a few years ago, the great majority of entering freshmen started in freshman mathematics or algebra and trigonometry. The fact that many of the better colleges and universities no longer offer these courses and even at institutions where the courses are offered, freshmen are starting in analytic geometry and calculus, I think indicates that new high school mathematics programs do constitute a better preparation for college than did the traditional program."

In this respect, the impact of the secondary school programs is tied in closely with, and cannot be considered apart from, education at other academic levels. Here, NSF is beset with unresolved problems.

One of the great questions is the proper balance between institutes programs at the secondary school level and those for elementary school and college teachers. Like an explosion bursting down doors on each side, results of the institutes for high school teachers show that similar massive programs at either end of the educational spectrum could pay rich rewards. Foundation officials are convinced of this but such programming would require larger scale financing than now envisioned.

Reasons for a major move into the elementary level are much the same as those in the early 1950's which led to launching institutes for high school teachers. At that time, the limited program at the college level alone was too much like trying to build a pyramid from the top down. It appears now that if students are going to be able to take full advantage of improved science and mathematics teaching and new courses available to them in high school, they must receive more and better training in elementary school.

Coupled with this fact has been the discovery as a result of work done in some of the course content revision projects that students can understand fairly sophisticated scientific ideas at a much earlier age than had previously been thought possible, if the material is properly designed and presented.

Yet the sheer numbers of elementary school teachers -- approximately 1,100,000, everyone of whom should know at least something about modern sciences and mathematics because they may have to teach these subjects -- complicates planning institutes programs for them. The realities of economics and availability of tax monies forces consideration to be limited to "master" or key teachers and to supervisory personnel -- at least for the near future.

At the other end of the scale, the NSF wants to invest more dollars in institutes for college teachers. Primary reason for this is the simple need to provide more training to prevent deterioration in overall quality of college faculties. Confronted with increasing numbers of students, the Nation's colleges -- particularly the junior, community, small liberal arts, and teachers colleges -- are under pressure to hire faculty members who have not received adequate training. In its budget request for Fiscal Year 1965, NSF estimated that of 88,000 college teachers of science, mathematics, and engineering, more than 13,000 required an additional three years of academic training, more than 25,000 required the equivalent of two years of training, and more than 20,000 required one additional year "to bring them to desirable minimum standards of training for college teaching." These estimates applied only to those who were poorly prepared in the first place and ignored the need of many college teachers to update themselves on recent advances in their fields.

The apparent training requirements for college teachers are magnified by what has been accomplished at the secondary school level. As students with revised high school training enter college, these institutions are shifting and upgrading their own curricula and teaching. The training needs of college faculties also lead back to the problems of pre-service teacher education and the function of the institutes for secondary school teachers. Unless it can be assumed that college teachers who themselves are in need of training can turn out well-prepared high school teachers, it appears clear that even if the undergraduate curriculum for pre-service teachers was changed overnight the institutes still would have to continue their role of providing basic education in science and mathematics for teachers already on the job.

Congress, while enthusiastically backing the training programs that directly affect secondary school teachers, has appeared reluctant to support NSF's efforts to build up its training programs at the college and elementary school levels.

Predictions of what Congress will do in the future are chancy affairs but, on the basis of past experience, it seems unlikely that the Congressional emphasis on the secondary school programs soon will diminish.

Since the main purpose of the institutes programs is to train teachers, NSF staff members regard the distribution of participants as an important factor. Institutes have been held in each of the 50 states in recent years but NSF officials believe that even if this were not the case the programs still would provide relatively even national coverage. This is because a teacher may apply to a Summer or Academic Year Institute in any state.

An important aspect of the manner in which NSF has distributed its funds geographically and by institutions is the relative lack of complaints that have been received. After grants are awarded each year a few schools let NSF -- and their Congressmen -- know they are unhappy because their proposals have not been approved. But NSF has been able to field these complaints with a minimum of trouble, thus indicating the system of temporary panels to evaluate proposals has worked well. From the Foundation's standpoint, probably the biggest problem with the panels is that they tend to be more reluctant than the NSF staff to support proposals that do not conform to the established institute pattern. When an offbeat proposal is supported, frequently it is because the staff has exercised its prerogative of reversing panel recommendations.

Because institutions that submit good proposals one year tend to submit good proposals in succeeding years while those that submit poor proposals tend to continue doing so, there is relatively little turnover among colleges and universities holding institutes. Grants for the 449 Summer Institutes in 1965 went to 293 institutions but only 37 or approximately 8 percent of these had not held institutes the previous year. Some of these so-called "new" institutions were not actually new to the program, having conducted institutes in years prior to 1964.

By way of comparison, there were 2,087 institutions of higher learning in the United States as of the 1963-64 school year. Of this group, 1,139 offered at least the bachelor's degree in science and mathematics and thus, for practical purposes, constituted the universe of eligible host institutions. There have been some exceptions, such as museums and junior colleges which held institutes under special arrangements, but these are a small minority. While most of the "name" colleges and universities do hold Summer Institutes, the fact that NSF is hitting only about a quarter of the eligible population limits any effects the institutes can have on the in-service and pre-service training of teachers in the United States.

As far as proposals to hold institutes go, there seems to be room for expansion in the Summer Institutes program for secondary school teachers. For 1965, NSF received 700 proposals from 380 institutions requesting support of Summer Institutes. NSF staff members believe that many proposals that were turned down would have resulted in good institutes if the Foundation had had the funds to support them. Best estimate is that about 100 proposals that lost out in the competition fell in this category.

Within individual institutions, numerous stresses and strains exist that also have important implications for the institutes programs. While a large number of Summer Institutes are staffed by the same group of faculty members year after year, signs on some campuses foreshadow flagging interest. Running an institute for high school teachers is no longer such a glamorous thing to do. Newer programs, such as NSF's summer science training projects for high-ability secondary school students, frequently now appear to attract more interest. A small but perceptible decline recently in the numbers of proposals to hold sequential institutes may reflect the desire of institute directors not to box themselves into long-term commitments.

Some institute directors point out that NSF competes with itself through providing increasing funds for research. This makes it tougher for a director to line up staff members. Often he imports staff. In a sense, this has brought the program back full circle to the early pattern of obtaining staff members for the institutes from outside the faculty of the school at which the institute was held. Where the imported staff members in the middle 1950's were the most distinguished lecturers available, their counterparts in the middle 1960's tend to be teachers from small colleges that do not have institutes of their own.

Lack of sufficient manpower to staff the institutes programs could be an ultimate restriction on their size. But it is not clear just where that ceiling is and the manner in which estimated ceilings have been broken down in the past makes predictions rash.

A number of observers have made suggestions of methods of improving the institutes programs. For example, Dr. E. G. Begle, Stanford University professor and head of the SMSG project, had two recommendations:

> "The first is that the number of institutes for poorly qualified teachers be increased. There are some institutes willing to take such teachers but there are not enough of them. The second is that there be an increase in the number of institutes aimed at developing selected school personnel into inservice institute leaders. Again, there are some institutes of this kind but not enough."

Another recurring recommendation is that NSF provide for pre-institute and post-institute training for teachers. To an extent, In-Service Institutes fulfill this function for the Summer Institutes, and the Summer Institutes for the Academic Year Institutes. Many teachers apparently would like something more specifically designed to prepare them for an institute.

Still other program changes have been suggested by knowledgeable observers. For instance, Dean George G. Mallinson of the School of Graduate Studies, Western Michigan University, Kalamazoo, Michigan, and long-time editor of "School Science and Mathematics," cited these four in an article in the February 1963 issue of his publication:

> "1. The subject matter is not organized into cohesive patterns, either within specific courses that are offered, or among courses that are professed to be integrated or sequential.
>
> "2. The content of the program of one institution is frequently repetitive of that taken in another. Consequently, participants 'retread the same ground' in successive Institutes.
>
> "3. The transfer of Institute credit from one institution to another is almost impossible to accomplish on a rational basis since the placement of offerings within the traditional graduate sequences is seldom feasible.

"4. The level of work offered in many Institute programs, and for which graduate credit is given, is frequently freshman or sophomore level."

Mallinson pointed out that these and other problems such as the number of repeaters, or as he said, the "Institute Bum," whose "nesting habits involve seeking entrance during successive summers to as many low-level institute programs as possible in invigorating summer climates," are to a large extent the faults of the system and not of NSF.

Foundation staff members feel many such criticisms are unjustified. They argue, for example, that the purpose of the institutes is to provide training, not to offer credit, and that the Federal Government cannot and should not attempt to design and enforce a program of training that would tie in with graduate sequences of a large number of individual institutions and result in interchangeable credits. NSF also is very sensitive to such phrases as "Institute Bum" and staff members point out that the "4-summer" rule imposed in 1962 probably has reduced to a minimum the number of individuals who can be classified under this label. With considerable validity, one NSF official added, "Of course, ideally we should not have a single 'bum' -- but who lives in an ideal world?"

Problems of this type listed by Mallinson are to some extent the price NSF pays for allowing as much freedom as possible to the colleges and universities that conduct institutes. There appears to be no question but that a greater degree of central control would make the program more efficient and many institute directors have urged NSF to grab the reins a little tighter. But moving in the touchy area of Federal aid to education, NSF has chosen to curb the impulses to be aggressive. To most people, NSF support without extensive regulation has been a key feature of the institutes programs.

It is probably because NSF does not bristle with overt controls that the institutes programs were able to get under way and then expand during a period when other efforts to provide large-scale Federal support for education were blocked by controversies over the questions of aid to parochial schools and to segregated institutions. That NSF was able to avoid these two blind alleys and to develop a mechanism for serving all groups of teachers is an accomplishment of no small magnitude. Viewed from this angle, the very existence of the institutes is a significant fact in United States education.

In contrast with NSF institutes, those run by the U. S. Office of Education under provisions of the National Defense Education Act could provide stipends only to teachers from public schools until the original legislation was modified in 1964. For teachers in Roman Catholic schools, who account for a large majority of the teachers in the Nation's private schools, the distinction that existed between the NSF and Office of Education institutes appears to have been important. Discussing the popularity of the NSF institutes among parochial school teachers, Father Koob said:

> "Perhaps these institutes had a special appeal to teachers in the Catholic school because they furnished the first evidence that some help from outside might be realized. Since they furnished a stipend, in contrast to the NDEA institutes, there was a much greater sense of satisfaction in being selected for such institutes. Likewise, the teachers involved felt that they simply had to produce and to sell the message of improvement when they returned to their respective schools. Whatever the reasons, our teachers eagerly sought the opportunity to attend these institutes."

Ever since the NDEA was passed in 1958 there has been speculation that management of the NSF institutes eventually would be transferred to the Office of Education. Such a consolidation might well create complications for the training programs in science and mathematics. Most institute directors, for example, undoubtedly would prefer to deal with NSF, which is part of the "scientific establishment," than with the Office of Education, which in many quarters is viewed as a stronghold of "educators." Some observers doubt the Office of Education would get the same amount of cooperation from the "scientists" as does NSF. And there is the simple fact that the science and mathematics institutes appear to be running smoothly under NSF's suzerainity.

Questioned in early 1965 about the chances of such a transfer, Representative Albert Thomas (D., Tex.), chairman of the House subcommittee which handles Foundation appropriations, pointed out that "NSF has done very well with the institutes." He said a transfer was unlikely unless good reasons could be advanced for making it, and added that "the burden of proof" would have to be provided on the side of the Office of Education.

Nevertheless, as NSF moves into the second half of the 1960's, speculation about moving the NSF institutes to another Government department continues. Whether this ever happens may hinge on the much-discussed possibility of creating a cabinet post for education. Such a move presumably would be accompanied by a general realignment and consolidation of Federal educational programs which, according to a 1963 Congressional report, are spread out among no less than 42 departments, agencies, and bureaus. This might result in a United States version of Ministry of Education, improving planning, coordination, and administration of Government activities in this field, but at the same time bringing to life the old bogey of Federal control of education.

As it stands now, of course, NSF does exercise "control" over its programs in a variety of ways. For example, institute directors have to file reports on what they have done, universities have to render financial accounting of how they have spent grant money, NSF staff members and consultants do visit institutes and file reports on what they see.

In its largest and most important aspects, however, NSF's control appears to be tacit and indirect. Controls of this sort carry no compulsion. High schools do not have to convert to one of the revised curricula programs -- and many have not. Teachers do not have to go to institutes -- and many do not. Colleges and universities do not have to accept grants if they feel NSF is infringing upon their rights -- and there have been instances where grants were turned down.

Ultimately, NSF is operating in a free market of ideas. It provides the support for various alternatives. It does pick and choose among them, and it can and has sought out groups or institutions to pioneer ideas that it favors. But the alternatives it backs have to be competitive to survive.

How does one add all this up?

Today the NSF Summer Institutes are, in a sense, all things to all people. There are institutes to upgrade the many teachers who never were fully ready for their current assignments. There are institutes that enable teachers to obtain advanced degrees to meet rising certification requirements in many states and communities. And there are institutes designed especially to prepare teachers to offer the revised curricula, such as BSCS, CBA, CHEMS, ESCP, PSSC, SMSG, and UICSM.

Impartial observers agree that in recent years the winds of change have been blowing vigorously in the fields of education but, when it comes to measuring the velocity that can be assigned to any single effort or concept, there exists wide variance. Certainly, however, the NSF institutes programs popularized a philosophy which has been both meaningful and apparently effective. But even to try to guess at percentage points has little, if any, realistic value.

In the long view of history, possibly the greatest contribution will be that the NSF institutes in general, and the Summer Institutes in particular, helped to focus an evolving philosophy of teacher training on a key idea: That subject-matter courses should receive essential emphasis. The "workshop" idea that centered around how-to courses has been supplanted by subject-oriented work, such as is given in institutes. This key idea has been adopted not only for other educational areas in the United States but by foreign countries. And while this educational reorientation was taking place, the institutes programs also played a quiet role in helping to integrate some Southern colleges and universities.

While the NSF institutes programs may not be the perfect or even the final answer, they appear to be the best solution that has yet been devised to achieve large-scale improvements in teaching of science and mathematics in United States schools, a goal desired by nearly all Americans.

From an operational standpoint, a major unresolved question appears to be whether the programs should be a lot larger than they are now. In 1963, Phelps estimated that the Summer and In-Service Institutes alone would have to provide 97,000 training opportunities annually to meet all needs. This was approximately three times the actual size of contemporary programs.

On the basis of teacher demand alone, his estimate appears accurate. During recent years, an average of three individuals have applied for each stipend offered in the Summer Institutes. The program also could be expanded on the basis of demand by colleges and universities to hold Summer Institutes. As reported earlier, staff members who have analyzed proposals believe that each year NSF turns down about 100 that would have resulted in good institutes if it had the extra funds necessary to support them.

But it is questionable whether more extensive training opportunities would draw many more of the "right" teachers. The study of nonapplicants showed that about half the Nation's science and mathematics teachers never had applied to an institute. It also suggested that these teachers, as a group, probably stood in greater need of institute training than those who did apply and attend. On the basis of this study, it is doubtful that a size increase alone would be enough to make an appreciable dent in the nonapplicant group.

The alternative, of course, is to "abandon" these teachers on the theory that they are beyond help and concentrate on providing adequate training for those who already are applying to institutes and are presumably among the "better" teachers. Cold-blooded as this may seem, this possibility has been suggested by some observers -- but not, at least not out loud, by NSF staff people.

The same study showed that nonattendees have summer obligations and commitments, from which they cannot or do not care to be released. Others want to spend the free time with their families. A few have very special reasons for not attending, such as one California teacher -- rated exceptionally capable by his superiors -- who reserved his summers to climb mountains, an avocation to which he was dedicated and which, he said, kept him fit to teach.

In the final analysis, two things seem clear: The institutes have become embedded in the Nation's educational system and, although it is difficult to describe with scientific precision the effects of these training programs, they have contributed to improving science and mathematics instruction in the United States. But beyond this, it also is apparent that the ultimate prerequisite for better teaching is adequate pre-service training of science and mathematics teachers, whether by NSF, other Federal agencies, the States, local communities, or private institutions.

First, it would seem, one should plug the leak if one ever hopes to obtain relief from the bailing operations that now constitute a large part of the institutes programs. Even if this is done, the task of keeping teachers abreast with the advancing and widening frontiers of knowledge still will confront, in perpetuity, whoever is willing to make the investment.

Quantitative Achievements of N.S.F. Teacher Institutes and other Teacher Education Activities

As a measure of the amount of supplementary training provided by teacher education programs of varying format, the concept of "academic year equivalent" (AYE) has been developed. AYE is defined as the average amount of instruction provided in full-time study for an academic year (9 months). In terms of this unit the various programs are evaluated (on the average) as:

Academic Year Institute (with related summer)	1.15	AYE
Summer Institute (average 8 weeks)	0.25	AYE
In-Service Institute (one course during academic year)	0.20	AYE
Coop. College-School Science Program (average 6 weeks summer or 1 course, winter)	0.20	AYE
Research Participation (average 10 weeks, summer)	0.30	AYE
Supplementary Projects (variable; based on past projects)	0.063	AYE

The estimated retraining needs of secondary school teachers are calculated as a minimum of one AYE every ten years (compare the college teacher's "sabbatical"). Thus the optimal annual rate of achievement of this goal should provide AYE's to the extent of 10% of the teacher population. As the attached table shows, the AYE's achieved a 5% level in 1961 and 1962, but have gradually dropped toward the current 4% level as the teacher population has increased.

The table for secondary school teachers shows a cumulative total of 400,000 teachers reached in 14 years; it should be noted that after taking into account multiple participation by individual teachers, this represents probably only 150,000 to 200,000 different individuals, and of these an undetermined number (perhaps 10,000 - 20,000) are no longer secondary school teachers.

The institutes for elementary school personnel have emphasized participation by key teachers and supervisors, who could multiply the training received through later activities in their own schools. As the table shows, the cumulative effort of 10 years has reached roughly 2% of the present teacher population, and only the equivalent of 0.5% in terms of the substantial training of an AYE.

Various annual studies show that the geographic distribution of teachers reached by the various programs approximates very closely the national distribution of the teacher population. Also, the ratio of applicants to participants is essentially constant in large and small schools and school systems. Therefore the geographic distribution of schools or of pupils reached is probably equally good.

NSF: PES/TES 5/10/67

Statistical Summary of Number of Participants and Number of Academic Year Equivalents for Secondary School Programs Fiscal Years 1954 - 1968

	Summer Institutes		Academic Year Institutes		In-Service Institutes		Cooperative College-School Science		Research Participation for High School Teachers		Supplementary Projects		TOTALS		SCIENCE TEACHER POPULATION	
	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Teachers	Partic/Pop Percentage Involved
1954-57	5,720	1,431	840	966	725	145	0	-	0	-	-	-	7,285	2,542	-	-
1958	6,200	1,550	925	1,064	3,000	600	0	-	0	-	-	-	10,125	3,214	158,000	6.41
1959	17,000	4,250	1,532	1,762	8,725	1,745	0	-	443	133	-	-	27,700	7,890	179,000	15.47
1960	17,350	4,337	1,491	1,714	9,026	1,805	0	-	497	149	-	-	28,364	8,005	190,000	14.93
1961	17,962	4,490	1,494	1,718	11,633	2,327	50	10	351	105	-	-	31,490	8,650	207,000	15.21
1962	20,469	5,117	1,725	1,984	13,826	2,765	280	56	369	111	-	-	36,669	10,033	208,000	17.63
1963	20,450	5,112	1,755	2,018	13,488	2,698	729	146	304	91	-	-	36,726	10,065	217,000	16.92
1964	20,410	5,103	1,684	1,937	13,085	2,617	938	188	359	108	-	-	36,476	9,953	226,000	16.14
1965	20,904	5,226	1,654	1,902	14,460	2,892	1,346	269	355	106	7,984	503	46,703	10,898	233,000	20.04
1966	20,538	5,134	1,547	1,779	13,492	2,698	2,016	403	364	109	7,646	483	45,603	10,606	238,000	19.16
1967*	19,550	4,888	1,494	1,718	13,636	2,727	1,920	384	377	113	3,760	237	40,737	10,067	248,000	16.43
1968*	17,655	4,414	608	699	13,453	2,691	8,000	1,600	389	117	12,500	788	52,605	10,309	255,000	20.63
TOTALS	204,208	51,052	16,749	19,261	128,549	25,710	15,279	3,056	3,808	1,142	31,890	2,011	400,483	102,232		

* Estimate

Statistical Summary of Number of Participants and Number of Academic Year Equivalents for Elementary School Programs Fiscal Years 1959 - 1968

	Summer Institutes		In-Service Institutes		Cooperative College-School Science		TOTALS		TOTAL TEACHER POPULATION	
	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number Participants	Number AYE	Number** Teachers	Partic/Pop Percentage Involved
1959	515	129	340	68	0	-	855	197	952,000	0.09
1960	545	136	405	81	0	-	950	217	984,000	0.10
1961	650	163	1,029	206	0	-	1,679	369	1,002,000	0.17
1962	712	178	1,060	212	0	-	1,772	390	1,026,000	0.17
1963	1,046	261	1,423	284	0	-	2,469	545	1,053,000	0.23
1964	1,236	309	2,118	424	26	5	3,380	738	1,090,000	0.31
1965	1,459	365	3,082	616	230	46	4,771	1,027	1,120,000	0.43
1966	926	231	4,225	845	1,215	243	6,366	1,319	1,141,000	0.56
1967*	0	-	0	-	1,504	301	1,504	301	1,163,000	0.13
1968*	0	-	0	-	4,000	800	4,000	800	1,179,000	0.34
TOTALS	7,089	1,772	13,682	2,736	6,975	1,395	27,746	5,903		

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* Estimate

** Source: Projections of Educational Statistics to 1975-76, Washington: U.S. Office of Education, 1966, Table 22.